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# Development of Franco-Latvian children's bilingualism in Latvia. Does the language of schooling matter?

Jonathan Durandin

*Centre of Cultural Research, Institute of Humanities and Social Sciences, Daugavpils University, Latvia  
e-mail: jonathan.durandin@bluemail.ch*

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## Abstract

Schooling plays a key role in the development of languages in children from bilingual families. This development depends on children's linguistic attitudes and practices, often in response to those present in their environment. Since school is a very influential socialisation body, children generally favour the acquisition or the learning of the language that dominates there. This tendency towards unbalanced bilingualism is all the stronger as the language of schooling is also dominant in the larger sociolinguistic environment. The aim of this paper is to understand the influence of schooling on Franco-Latvian children's choice of preferred language in the Latvian diglossic context. This contribution analyses the cases of four children, aged between 8 and 11, attending school in Latvian, Latvian-Russian or French in Riga, the capital of Latvia. The results of the discourse analysis, which was based on a set of two interviews per child, showed that these children do not favour the language of schooling and sometimes even reject it. Their language choices are not based on the schooling function of languages but rather on the basis of other functions that they attribute to languages inside and outside school – communicative, social, identity and affective functions as well as recreational or formative functions. These results led to a discussion on how focusing on one or more of these language functions in school to influence the development of Franco-Latvian children's bilingualism in the Latvian context.

*Keywords:* bilingual children, schooling, linguistic attitudes and practices, language social and psychological functions

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## 1. Introduction

This paper discusses the influence of the language of schooling on the development of bilingualism in children with parents from different sociocultural and sociolinguistic backgrounds. The language of schooling is often favoured by bilingual children, whether they belong to monolingual or bi/plurilingual migrant families or mixed families, with one of the parents being a native speaker of the language of the school. The bilingual child then generally uses the language of schooling more than the language used in the family, whether the family is migrant or mixed, monolingual or bi/plurilingual. This phenomenon seems to be reinforced when the language of schooling is also dominant in the broader linguistic environment, at the societal or national level. The author of this article wishes to verify this phenomenon in a particular context and from an ecological and sociocultural perspective by considering the interrelationships between languages, the speakers of these languages, and the environment in which they find themselves (van Lier 2004: 1-22).

The research field is located in Latvia, a north-eastern European state founded in 1918 but annexed by the USSR at the end of the Second World War until 1991 when the country regained its independence. From a sociolinguistic point of view, these historical events have nurtured a conflicting diglossia between the Latvian and Russian languages, which has subdued since the beginning of the 2000s. In Latvia, Russian is a language used widely and daily in informal situations of everyday life – in business, commercial relations, and the media. However, since Latvia regained its independence in 1991, the Latvian language has been able to obtain and establish its status as a national language. Thanks to a strong language policy, this language is used in formal and administrative communications, educational institutions, the media and business, as well as in everyday life. The distribution of the use of the two languages is generally accepted by the population, which consists of approximately 60% ethnic Latvians, 26% Russians, and 14% of many other minorities, including Belarusians, Ukrainians, Poles, Lithuanians (Kibermane and Kļava 2016: 40). In this diglossic context, most educational institutions operate in the Latvian language. However, there are currently public minority schools where Latvian is the language of 60% of the curriculum subjects. In comparison, the minority language is used for 40% of the subjects, usually related to the culture of the minority concerned. There are still a few schools which, by agreement of the Latvian Ministry of National Education, teach in a foreign language, usually English but also German or French, with reinforcement courses in Latvian and Russian.

As a result, the language of schooling for Latvian bilingual children is not necessarily the dominant language in their linguistic environment. They may be members of 'regional' linguistic minorities, such as the Russian language speakers, or of more recent immigration, particularly from Western or Southern Europe. Moreover, on the international scene, the Latvian language does not hold a significant status, nor does the Republic of Latvia politically, economically or culturally. Such being the case, to what extent does the language of schooling have an impact on the development of children's bilingualism? Is Latvian preferred as the

language of schooling, irrespective of the languages constituting the children's bilingualism? Do children favour the other languages of schooling in a context where the Latvian language enjoys a relatively dominant status?

To answer these questions, the study examines a few cases of children from Franco-Latvian families living in Riga, the capital of Latvia, and attending school either entirely in Latvian or in Latvian with some instruction in Russian, or French only. After having delimited the theoretical framework on which this study is based, the research methodology and the participants in this research – four children aged between 8 and 11 – will be presented. The results of the study will allow one to understand that these children do not favour a language because it is the language of schooling, but for the functions they attribute to it in the context of school and elsewhere.

## 2. Sociolinguistic representations of bilingual children

In order to present the theoretical background on which our study is based, it is first of all necessary to specify what a bilingual child is, which allows to define the profile of the research participants. Next, it will be explained why a study of the sociolinguistic representations of bilingual children is useful in order to identify the language they prefer and to understand the reasons for this choice. Finally, in order to formulate hypotheses to guide our analysis, it is useful to understand what a language of schooling is and why it is likely to be valued by bilingual children.

*2.1. The type of bilingual children this research is focused on.* In this research, like for many researchers in sociolinguistics at present, bilingual people are considered “not so much as the sum of two (or more) complete or incomplete monolingual but rather as a specific and fully competent speaker-hearer who has developed a communicative competence that is equal, but different in nature, to that of the monolingual” (Grosjean 2001: 11). A bilingual person is anyone who uses two or more languages in their daily life. Bilingual people regularly use several languages on a daily basis but at different levels of competence, where one language can be spoken, read, written and understood while another is only read and written or spoken and understood. This is because bilinguals generally apply a complementary principle: they acquire and practice their languages for different purposes and in different contexts and domains. For the children that we focus on, one language can be used in an extra-curricular activity around music, while another will be used in leisure activities with friends. In addition, bilinguals adapt their language practices and attitudes to their interlocutors who may be monolingual or bilingual as well. Finally, it should be noted that the objectives, domains and contexts of language acquisition and use may evolve and, as a result, the language skills, repertoires and attitudes of bilinguals may change at the same time (Grosjean 2004: 34). For research on bilinguals, all this suggests that “their total language repertoire, and the domains of use and the functions of the bilingual's various languages are being taken into account” (Ibid.; 12).

Indeed, bilingual children can be or have been either simultaneous bilinguals or sequential bilinguals. Paradis (2007: 15) points out that “simultaneous bilingual children are those whose dual language learning experiences began at birth or at least before the age of 3”, which is usually the case when two parents speak two different languages to their child. Sometimes this type of bilingualism can develop when one language is used at home while another is used at daycare. As for sequential bilingualism, it is characterised by the fact that “one language is introduced after the other language has become somewhat established, e.g. after the age of 3”. Sequential bilingual children often acquire and use their first language (L1) at home with their parents and their second language (L2) at school. Concluding work on language acquisition in both types of bilingualism, Paradis (ibid: 33) notes that “there are important differences between simultaneous and sequential bilinguals, most notably in differential proficiency levels between the languages. L2 learners at the early stages have a proficiency gap between their two languages that is larger than the gap between a simultaneous bilingual's dominant and non-dominant language.” However, referring to other works (Oller and Eilers 2002; Gathercole and Thomas 2005), Paradis points out that “differences in abilities in both languages between simultaneous and sequential bilinguals may diminish by the end of elementary school if both languages are highly supported in the community and educational systems, and sequential bilinguals began learning the L2 at least in kindergarten”.

For the purposes of this research on Franco-Latvian children living in Latvia, it is expected that most of them will be simultaneously bilingual and have a good enough command of the French language to be able to take part in the interviews, allowing their sociolinguistic representations to emerge.

*2.2. Sociolinguistic representations.* The study reported in this article is a part of a larger research project which aims to identify the sociolinguistic representations of Franco-Latvian bilingual children living in Latvia in order to understand how these children interpret and influence their environment.

Sociolinguistic representations are social representations relating to the language practices of speakers (linguistic repertoire, social use of languages, modes of language acquisition or learning) and to the value systems that individuals apply to the different languages they use or which are used in their environments (Maurer 2016: 7-8).

Social representation is “a form of knowledge, socially elaborated and shared, having a practical aim and contributing to the construction of reality common to a social group” in relation to the object to which it refers, which in this case is languages. From the social representation of a given object, “the diffusion and assimilation of knowledge, individual and collective

development, the definition of personal and social identities, the expression of groups, and social transformations” are defined. Thus, social representations “engage the social belonging of individuals with the affective and normative implications, with the related internalisations of experiences, practices, models of conduct and thought, socially inculcated or transmitted through social communication” (Jodelet 2003: 53).

According to P. Moliner, P. Rateau and V. Cohen-Scali (2002, 25), “social representations are most accessible to us” in “individual discourses (which) will be characterised both by their variability and their convergence. Variability in the modes of expression and in the experiences of each individual, convergence in the meanings attributed to the object and in the reasoning logics”. Thus, through interviewing the children and carrying out analysis of their respective discourses, it is possible to understand the common meaning that children give to their practices and attitudes specific to the languages which make up their bilingualism, and by focusing more particularly on the language of schooling.

*2.3. Language of schooling and language functions.* For the purposes of this study, it is necessary to identify how Franco-Latvian bilingual children talk about their practices and attitudes, primarily in relation to their language of schooling. However, the languages of these children are part of contexts other than school, and it will be necessary to identify the practices and attitudes of children in their other language of bilingualism in order to understand which language is favoured in general.

The language of schooling is understood here as the language that the laws or regulations impose on a child’s school activities. The various actors who supervise and facilitate a child’s schooling must consequently use this language with the child. The language of schooling is therefore not only symbolic of schooling but also a support for it and is a part of the children’s school experience. Schooling is “a publicly organized practice” which initially takes care of the future citizen’s “acculturation and education”. Over the decades at the end of the 20th century and at the beginning of the 21st century, “schools simultaneously took upon themselves increased responsibility for providing children with technical skills, a sense of civic responsibility, personal development, mental and physical health, cultural awareness, and all the rest” (Austin, Dwyer and Freebody 2003: 20). Thus, schooling helps the human being (i.e. the child) to develop and fulfil themselves. It prepares them for employment. It is a means of socialising the child and applying conservative social control over them and their peers or integrating them into a movement for social change (Chitty 2002: 2-5).

The language spoken in the family is often undermined if the language of schooling is also the dominant language in the national or social environment in which the bilingual child is located, or if the particular language has a significant overall status otherwise. As a result, the language spoken at home is minimised because it is the language of socialisation in the family environment and does not allow for socialisation and integration into the wider society (Cazden 2001: 88). It is the language of schooling that is then privileged, and the bilingual child develops unbalanced bilingualism, regardless of family language policies (Deprez 1994: 93-101; Yates and Terraschke 2013: 114-116).

However, if the language of schooling is not that of the bilingual child’s social environment or their peers outside school, its value may be underestimated. This seems to be often the case among adolescents and pre-adolescents (Deprez 1994: 64-65; Caldas and Caron Caldas 1999). In fact, the phenomenon of language minimisation-enhancement does not seem to depend on the schooling language status attributed to it. This phenomenon is highly dependent on children’s linguistic experiences, practices and attitudes that are built into the relationships they have with others inside and outside the home, especially with peer groups (Deprez 1994: 82-87; Fogle 2013).

### **3. Methodology and participants**

This study aims first to identify the language of schooling, and, above all, to understand the relationship that children have with this language and with the language used outside school. This requires an analysis of children’s discourse in order to understand how they perceive the interrelationships between languages and people within and outside the school context. In the analysis of sociolinguistic representations, particular attention must be paid to the expression of the socialising function of languages, which seems to be a determining factor in the choice of the language preferred by bilinguals.

*3.1. Semi-structured interviews and discourse analysis.* The research material consists of records of semi-directive interviews carried out twice with bilingual Franco-Latvian children. The first interview took place between each child and a parent, followed by a second interview with a researcher. Since each child participates in two interviews, it is necessary to allow the child enough time between the two interviews to forget the exact content of the first interview and not to be tempted to repeat their earlier statements in the second interview automatically. Furthermore, as the research is synchronic, the two interviews should not be conducted at a too wide interval, as the children’s language practices and representations may change too much (see above). It was therefore decided to take approximately six months between the two interviews with each child to analyse their sociolinguistic representations at a given period. These two interviews took place in French and in accordance with the same interview guide to address the following topics: the child’s linguistic practices, the child’s relationships to the languages they use, in particular considering the difference between the language of schooling and the other language, the child’s relationship to bilingualism and bilinguals, and the cognitive and emotional processes at work in the bilingualism experienced by the child.

Each interview has a very different enunciation context. In the first interview with one of the parents, the two interlocutors give an insight into the relationships that are being played out between them or with other people, e.g. parents or classmates, concerning languages and bilingualism. In the interview with the researcher, the relationship between the two respondents is much more neutral, but the child generally engages in co-enunciation, especially since they have generally forgotten what was said in the first interview with the parent. This is an opportunity for the researcher to note what the child repeats or adds, confirms, completes or contradicts in relation to the interview with the parent. This procedure makes it possible to obtain information that is both precise and nuanced about each child's sociolinguistic experiences, practices and attitudes, and about the interrelationships of each child with the languages and people involved in one context or another.

The transcripts of the interviews allow an analysis to be made of the constituent elements of the co-enunciation process of each interview, based on the SPEAKING model of Hymes (1977: 53-62). At the same time, it is important to take into account the linguistic marks of children's subjectivity and positioning in relation to the topics raised in the interviews, including that of languages at school.

*3.2. Participants.* The selection of research participants takes into account the fact that the Latvian environment is not particularly French-speaking and that younger children are unlikely to be able to express their thoughts precisely on subjects they may not discuss at home or school. In addition, it is known that the skill differences between the two languages of bilingual children tend to fade away by the end of primary school (see above). Thus, it seems necessary to conduct interviews with children who are at least 8 years old and therefore in the primary school stage in Latvia, which is attended by children aged 7-11 years.

Four children participated in an exploratory stage of the research. All four children have French-speaking fathers of French nationality; two of the children, Anna and Roberts, have Latvian-speaking mothers, while the other two, Marija and Alina, have Russian-speaking mothers. The two Latvian-speaking children were 8-9 years old at the time of the interviews, whereas the two Russian-speaking children were 10-11 years. The rest of the information on the children's environments shows great heterogeneity between the children's family language situations and practices (Table 1).

Research results show that children's language situations and practices at school are also very heterogeneous. However, children's attitudes to languages are partly congruent with regard to the status of their language of schooling.

**Table 1.** Children's profiles and family environments

Interviewee (pseudonym)	Anna	Roberts	Marija	Alina
First languages	French and Latvian French-speaking father, Latvian-speaking mother		French and Russian French-speaking father, Russian-speaking mother	
Age at the time of the interviews	8	8-9	10-11	10-11
Family situation	Married parents. She lives with her parents in Riga.	Divorced parents, one younger brother (4 years old). He lives with his mother in Riga and sees his father during visits or on school holidays.	Divorced parents, one younger step-sister (2 years old) from her father's side. She lives alternately with both her parents: 2/3 of the time with her mother, 1/3 with her father.	Divorced parents, one older sister (13 years old). She lives alternately with both her parents.
Declared family language practices	Family languages are French and Latvian (principle of one parent-one language principle applied in an open way). Parents speak English and Russian to varying degrees.	His mother speaks Latvian and French with her children. His father speaks French with his children. The father speaks English and some Latvian; the mother is fluent in French, English and Russian.	Parents used to speak English in the family, and each one spoke their own language with their daughter. Currently, her mother speaks with her in Russian. English is the spoken language within her father's family, but he speaks French to his daughter. The father's partner can speak Russian.	Parents used to speak French and English in the family. Currently, her mother speaks Russian with her children. She also speaks French and English. No information available on her Latvian language practice. Her father speaks French with his children. He speaks English otherwise. His

				knowledge of Latvian is not specified.
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#### 4. Research findings, discussion

In the following section, the aim is first to identify the languages of schooling of the four children and their linguistic practices at school and in other contexts. The analysis of the children's relationship to their languages and bilingualism makes it possible to understand how the children display an 'egalitarian bilingualism' where the languages of schooling are not preferred. Explaining the reasons for this phenomenon enables the author of the paper to suggest ways of developing the bilingualism of Franco-Latvian children in Riga's schools.

*4.1. Children's languages of schooling and language practices at school.* The information collected to identify children's language of schooling is mainly taken from the initial interviews with parents who had taken the responsibility to interview their child. During the two interviews the children had, they seldom pointed to a language as the language of schooling, useful for learning activities in the classroom, or as a medium for interrelationships between people. However, some observations can be made concerning children's languages of schooling and their language practices at school, summarised in the table below (Table 2).

Only one of the four children has attended school in a single language – Anna. She has always been educated in schools where Latvian was the language of schooling. The other three children have had different languages of schooling throughout nursery school and later in primary school. Before relocating to Latvia, Roberts attended a nursery school in France for 1 year; after that, he attended a Latvian-language school in Riga – first in a pre-school for 2-3 years, then a primary school. Alina first attended a Russian-speaking nursery school for 1 year before enrolling in the only French school in Riga which she was still attending at the time of the interviews. At that time, Alina also had compulsory Latvian language courses at school and private Russian lessons. As for Marija, she attended a nursery or pre-school in French (in the same French school as Alina) for 3 years and then attended a Russian-speaking minority school in Riga. At the time of the interviews, she had lessons in Russian and Latvian at school, the Latvian language being used more and more in the classes over the years. Concerning minority schools, it should be remembered that the Latvian language must be used in the majority there – in teaching and administrative contacts (Pluča, 2019).

Three children attended school in several languages. At the time of the interviews, all of them were in schools where other children and teachers likely belonged to different language communities. However, most of them describe their schools as being monolingual. Marija does not talk about the use of Latvian in her minority school and talks very little about school activities or her contact with classmates in Russian. Anna and Roberts talk about school activities in Latvian and their contact with classmates in Latvian. Only Alina describes the context of her French school as a multilingual environment where French is present with Russian: "At school, I speak French with my friends who do not speak Russian and with the teachers and all that, at school".

**Table 2.** Children's languages of schooling and language practices at school

Anna	Roberts	Marija	Alina
Schooling in Latvian since pre-school	Nursery school in France for 1 year, then schooling in Latvian since pre-school	Pre-school in French for 3 years, then schooling in Latvian and Russian in a public minority school	Pre-school in Russian for 1 year, then schooling in French
School described as monolingual			School described as plurilingual
Latvian in written form in classes		Russian in writing	French as language of knowledge
Interpersonal relations with their peers in Latvian		Few interpersonal relations in Russian	Interpersonal relations in Russian

School activities in the schooling language mentioned by children are few, and all are identical, i.e. activities related to the written language. When asked by her mother where she reads in Latvian, Anna replies: "I read in Latvian at school," before adding "I also read a lot at home". Roberts, who also reads in Latvian, prefers "reading at school rather than at home," and when he writes "it's for school". When asked about her writing practices in Russian, Marija replies: "I write at school or when I need to do my homework". It is interesting to observe that she also mentions in one interview the period when she was learning to write in French with "one of her teachers [from] the French school". As for Alina, she does not mention the written practice of French in her school unless prompted, even though it is her language of schooling. To her mother, she replies that she writes in Russian but does not mention French at all. In her interview with the researcher, she talks first of all about her practice of reading

in French for pleasure. Her interviewer led her to talk about the school practice of reading: “We are told to read texts and only in textbooks”. When asked if she writes in French, she replies briefly: “At school, I write in French [...] for lessons”.

Writing in Latvian is also a practice for Anna and Roberts with their classmates. Anna writes small notes for friends at school. Roberts says: “I have a friend, we write a lot, we play at school, lots of things like that, we write and draw more, but we write”. Marija does not talk about her relationships with her classmates, while Alina talks to the researcher about “games where you have to write [...]”, such as the exquisite corpse, “[...] and [she plays] in Russian”. It should be added that Alina regularly mentions in her interviews that she shares moments with school friends to play, discuss or even sing (“sometimes we sing with the girls, in pairs or threesomes”) in Russian. Anna and Roberts also often talk about their social relationships or games with their peers at school, which always take place in Latvian.

As far as after school activities are concerned, only Alina talks about them in great detail. She mentions the choir where all the activities take place in Russian. She also explains that, at the music school, she communicates in Latvian as well as in Russian; whereas she could follow her music theory lessons in a Russian-speaking group, she is in a Latvian-speaking group, but she can speak Russian with the teacher in case Alina requires clarification.

The language practices declared by the children in the school indicate the language they prefer. It is evident for children whose first language is Latvian and who attend Latvian-speaking schools – Anna and Roberts. Latvian seems to be the primary language at school for these children. They practice it in written form in classes where teachers seem to be absent, and both in written and oral form in friendly relations with their peers. On the other hand, the languages of schooling of the two Russian-speaking children do not seem to play a significant role in their lives, in competition with other languages. Marija only speaks about her practice of Russian in writing, without mentioning the presence of a teacher. She never talks about her school practices in the Latvian language, which is, in principle, the major language in her schooling in a minority state school. She mentions very few interpersonal relations in Russian with classmates and never in Latvian. Alina presents a clear separation between written French, the language of classes and knowledge, and Russian, which allows for interpersonal relations in places of learning. Latvian is also found in her second interview as the language of music teaching.

*4.2. Children’s language practices outside school.* The children speak very little about school, classroom activities, and languages in class and at school. They are much more talkative about their relationships with family and friends and their language practices in these settings.

Anna and Roberts use their language of schooling, Latvian, with other Franco-Latvian children outside school in games where the French language also appears. Their French-speaking friend circles consist of 3 to 5 children, but Anna widens this circle by making friends with two to three adults from her parents’ friend circle. Latvian and French are present in the family circle. The French language is mentioned by Anna mainly in interactions with her father through common reading, watching films, games, songs, which is also the case for Latvian with her mother. For Roberts, Latvian is presented only in his second interview with the researcher as the language of everyday communication with his Latvian mother and grandmother. French is also a language of communication with his mother: a language of secrets when he wants ‘nobody to know’ or a substitute language when he does not know how to express an idea or designate an object in Latvian. French is the language of play activities, for example, chess, and oral interaction with his father. For both children, French and Latvian are presented as the languages of personal, solitary activities, for example around singing (Anna and Marija), reading, audiovisual consumption (with a preference for French for Roberts), internalised games. Finally, it is noteworthy that social relations in Latvian are rarely mentioned by the two children, almost as little as those in French, which are almost non-existent in the Latvian context.

Concerning Latvian practices, Marija does not talk about them in her interviews. Alina mentions briefly speaking Latvian “in the shops”. On the other hand, Russian, which is Marija’s other language of schooling, sometimes appears to be useful for social interaction in Latvia. For both girls, Russian is the language of family interrelationships with the mother, grandmother and, in Alina’s case, also with her sister. Marija also speaks Russian with her father’s partner, a woman who is neither Latvian or French, or Russian. However, in all cases, the family practices in Russian are not specified, but it can be assumed that these are mainly discussions. The two girls talk about their Russian language practices in their solitary activities. Alina mentions briefly the fact that she invents games, reads and watches television programmes in Russian, and that she also likes to sing. Marija is much more specific about her independent activities. She reads comic books and youth literature, watches YouTube channels, creates characters that she stages in videos, comics, or on Gacha Life (a game connected to an international social network) in both Russian and French languages. As for the exclusive use of the French language, it takes place in their paternal family context for both girls, mainly in conversations with or in the presence of the father.

It is noticeable in the statements of language practices outside school that the children’s language of schooling is not always present in their activities within their friend, family or personal circles. Upon closer examination of the extent of the sociolinguistic circles in which these children are involved, and to the range and frequency of their use of their first languages, it can be considered that their locally established languages are used more often and in more diverse situations in their school and social lives than the French language. Anna and Roberts, therefore, seem to favour Latvian, while Alina and Marija – Russian. However, French plays an essential role in the children’s family and personal lives. In fact, the children present as many

or the same practices in French as in the local language, especially in their personal, solitary activities. This inclination is generally confirmed in their relationship to languages and bilingualism.

4.3. *“Egalitarian bilingualism”, where languages are on equal footing.* As it has been explained in an earlier paper by the author (Durandin 2020: 49 - 54) based on the children’s first interviews – and as has been confirmed in the analysis of the second set of interviews –, the four children present their bilingualism as a commonplace phenomenon which they normally experience on a daily basis while also valuing it.

4.3.1. *Children’s positive attitude towards bilingualism.* This positive attitude towards their bilingualism, bilingualism as such, and its commonness is revealed in various ways, more or less explicitly.

First of all, the children make it clear, as Alice does in her second interview when asked about her impressions of speaking two languages: “I don’t think it’s special, but it’s good”. Anna, Marija and Roberts state at one point or another in their interviews that they love the two languages that make them bilingual or that they love to speak two languages in everyday life. Moreover, the children regularly present themselves or even claim to be bilingual or even plurilingual. Marija’s responses at the beginning of her two interviews are symbolic of this. In her first interview, she insists on the fact that she can “have thoughts in Russian” when she is in France and “thoughts in French” when she is in Latvia. In her second interview, when her interviewer informs her that they are going to discuss the languages she speaks, quoting French and Russian, she adds “Yes, both, or others,” before adding that “we were always chatting in English, I learned it after Russian and French”.

It is also noteworthy that some of the children sometimes value their bilingualism in their interviews at a time when it is a matter of discussing only one language or the other. As an example, while Anna has to explain when she speaks Latvian in general, she instantly points to her father, who is French-speaking by birth, and to “other children who understand French or Latvian”. Franco-Latvian bilingualism may also be desired, claimed, or be shown in a positive light in a monolingual context. This is noticeable, for example, in the school context. Anna would like French to be spoken at school because “it would be fun to speak French in school”. Alina considers that “speaking when [she is] at school all the time in French would not be very cool” and adds that she likes to speak “different languages even in school”, which probably implies that she would like to continue speaking Russian with her classmates in her French school. Marija notes that she uses French at school because “there are classmates who are interested in this language” and that she can therefore “teach them words”. Roberts points out in both interviews that he is admired in his school for speaking French. When he speaks French, “everyone says Whaouh”, and that “there are girls who really like” it, especially “the older ones, the very older ones”, and to such an extent that “they will learn” it.

4.3.2. *Bilingualism based on functions attributed to languages.* These latter excerpts from interviews lead to the observation that the children construct their relationship to bilingualism not according to the domains of linguistic use but rather according to the social and psychological functions they attribute to languages.

The functions identified in the interviews are as follows: a language can fulfil an interpersonal communicative function with a particular person or a social-communicative function in a given context or group. Alina invokes this double function when she points out that Russian at the French school is the language of discussion with her classmates, which is what Anna seems to want to experience with French in her Latvian-speaking school. A language can also be used to develop one’s identity, in relation to oneself and without the involvement or influence of others. This personal identity function is especially mentioned when children talk about handling or learning a language, such as when Anna records herself reading a text and listens to herself again for the pleasure of hearing her voice. A language may have another sociocultural identity function that enables the child to integrate into or separate from a given social group. In the previous excerpts, Marija and Roberts insist that French is a means of showing off, but it also allows one to show an identity apart from those of the other children in the school. Two affective functions of languages have been identified: intrapersonal and interpersonal. A language thus enables one to establish an affective relationship either with oneself or with others, usually relatives or friends. In Anna’s case, French and Latvian enable her to establish and maintain strong links with herself and her parents through early childhood songs sung for herself and those she sings together with her parents. A language can also fulfil a formative function when it is used to learn, to enrich knowledge or to develop skills. Finally, a language can have a recreational function which is often expressed in the consumption of cultural objects.

When the focus shifts from the domains in which their first languages are used to the functions they attribute to them, it appears that children tend to present bilingualism in which the languages have similar or even equal values. Children construct this ‘egalitarian bilingualism’ in several ways. They do so by highlighting or not evoking a linguistic function, or very little, in contrast to the practices that the domain referred to should induce. Thus, schooling languages are generally not presented in terms of a schooling function understood in its strict sense, i.e. for the fact that it enables children to follow their lessons and experience their schooling, particularly in their relationship with teachers. Apart from Roberts, the formative function of these schooling languages is very little presented by the children, as if these languages had almost no role to play in the development of their knowledge and skills. On the other hand, Anna and Roberts show the interpersonal communicative function of the Latvian language in their relationships with classmates. Alina presents the schooling and training functions of the French language on very rare occasions but regularly reminds that the Russian language serves her interpersonal relations with her

friends at the French school. Marija hardly mentions the educational, formative or interpersonal communicative functions of her languages of schooling, Latvian and Russian. Children build the balance between the languages that make up their bilingualism also by highlighting the functions of one language that the other does not fulfil. They do so, for example, when they point out that Latvian or Russian languages have a communicative function at a local level in Latvia, but that French fulfils this function in France and other countries in the world. When it comes to the sociocultural identity functions of languages, particularly among Latvian-speaking children, French makes it possible to stand out positively or to isolate oneself from the Latvian context, whereas the Latvian language can be a means of integration into the local community. Finally, children present or try to attribute similar functions to the languages that make them bilingual, albeit rarely. Such is the case for the recreational function of all languages, even if Russian and French seem to have a quantitative and sometimes qualitative advantage in the field of audiovisual productions.

Children's attitude to their bilingualism and languages suggest that the languages of schooling for these children are not particularly privileged in their sociolinguistic representations. The status of the language of schooling does not encourage children to consider it a language for personal development in the school context, a language for the preparation for the future professional life, or as a language for selecting the best among pupils. Instead, it appears to be the language of communication or even socialisation with the children at school, as is the case for Anna and Roberts. However, the French language is also considered by these children as an important language in their bilingualism for the different functions they attribute to it, including its communicative functions at interpersonal and global levels. The Latvian language as a language of schooling is non-existent for Marija, who, moreover, hardly presents Russian at all in the school context. As for Alina, she recognises the status of French as the language of schooling and quickly evokes its social-communicative function with some of her classmates, whereas she values this function for Russian.

*4.4. School and development of Franco-Latvian children's bilingualism.* According to the findings, the status of the language of schooling is considered neutral by the interviewed Franco-Latvian children. This neutral status seems neither to diminish nor to increase the value or influence of a language in the context of bilingualism for these children. However, the functions attributed to languages do influence the bilingualism of these children. If the school is to participate in the development of the children's bilingualism – which seems necessary to the author to facilitate the full development of rich identities that are potentially open to others – certain language functions must be brought into play in school activities.

It can be seen that the children interviewed use one language more than another at school and that it is favoured in their practices without, however, being favoured in their sociolinguistic representations and attitudes. Thus, they give meaning to what they experience in the contexts in which they live. As these children are simultaneously bilingual, the French language and the dominant language in Latvia shape their bilingualism and is quite likely a part of their identities. Even if family configurations are not favourable to the preservation of the French language, or the organisation of schooling favours the development of one language rather than another, these children seem to want to preserve their particular bilingualism if not in fact then at least in their representations. To this end, each child attributes functions to their languages which may be similar or different, complementary or not. Each of them decides which personal and affective identity functions (in relation to themselves and others) they attribute to specific languages in order to integrate them more or less actively in the development of their bilingualism. As for the attribution of other functions to their languages related to communicative, sociolinguistic, or sociocultural relations, it should be noted that Franco-Latvian-speaking and Franco-Russian-speaking children apply different strategies. Franco-Latvian-speaking children seek to construct a representation in which the dominant status of the Latvian language in the school and social contexts is counterbalanced by the dominant status of the French language in the global context and by an equal status for both languages in the family context. The two Franco-Russian-speaking girls neutralise the dominant status of the Latvian language as much as possible in school and social contexts by valuing all the functions of the French or Russian languages in the contexts in which they practise these languages, from the smallest to the largest scale.

The children interviewed do not perceive school as a place where they can develop their bilingualism, characterised mainly by the presence of the French language alongside the Latvian or Russian languages. Therefore, according to the author, it seems useful to propose activities that promote the valorisation of the languages of these bilingual children, or even other bilinguals, in the schools of Riga. The children could be offered activities that allow languages to be used for their personal development and expression, without paying any attention to the surrounding diglossic context. The activities using the formative function of languages could enable them to develop (later or simultaneously) their personal identity function through the use of the language, and their affective functions with themselves and those around them. It should be noted that the recreational function of languages can also be put to good use: it is favoured by the children and would make it possible to initiate the implementation of the functions previously mentioned. The implementation of these language functions could undoubtedly take the form of creative activities where children's knowledge and skills could be used to carry out individual or small group projects in one or more languages. These projects would allow the sharing of ideas and emotions with others – peers or parents, as well as their teachers. These could be literary or stage writing projects, or even singing performances. One can imagine other projects whose outcome would not be so explicitly linked to children's language productions: an exhibition of graphic or photographic works, a concert on a given theme, a video production by the children, and the like.

## 5. Conclusion

This study leads to the conclusion that for bilingual French-Latvian-speaking or French-Russian-speaking children aged 8 to 11 living in the Latvian diglossic context, the status of their first languages in relation to a given domain (school, family, and others) is less important for the development of their bilingualism than the functions they attribute to their first languages in that domain.

However, the organisation of the functions of languages in the sociolinguistic representations of these children would require to be detailed in order to understand the effective value of a language function in the development of a child's bilingualism in a given domain. This detailing would probably involve both qualitative and quantitative analysis of the distribution of language practices and the components of children's sociolinguistic representations in relation to the functions attributed to their first languages. It is necessary to design another research methodology which would combine these two approaches.

In the field of Franco-Latvian language and education policy, this study encourages the realisation of bilingual projects which would not challenge the Latvian authorities' language policy in favour of the Latvian language, while at the same time promoting the bilingualism of each child. This could be an opportunity to carry out pilot projects with Franco-Latvian bilingual children and the teaching teams of schools hosting these children. However, as the school is not the only body that develops the bilingualism of children, it would be necessary to involve parents in this development process, e.g. informing and training parents about bilingualism, as well as their symbolic or concrete participation in projects implemented in schools.

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# Enhancing the Writing Skills of B1 Level Primary School Students in the Foreign Language using WEB 2.0 Tools

Antonia Loutsi<sup>1</sup>, Makrina Zafiri<sup>2</sup>

<sup>1</sup>English teacher in private primary school  
BA in English Language and Literature  
M.Ed. in TESOL

<sup>2</sup>Foreign language Office, Aristotle University of Thessaloniki, Greece.

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## Abstract

This research investigates the influence and usefulness of integrating Web 2.0 tools in teaching writing to B1 level students in English and the extent to which the use of Web 2.0 tools motivate students in their writing process. The paper focuses on the hypothesis that students of a B1 level are able to develop their writing skills successfully with the aid of Web 2.0 tools during the English language learning process. For the needs of this research two students who attended private tuition and were preparing for the KPG B1 / B2 May 2020 exams, participated in the research. They were both thirteen years old and belonged to the same language level. Qualitative and quantitative findings were analyzed providing valuable information and suggestions for Web 2.0 tool implementation in English learning classes. The outcome of this research shed light on the influence of technology, and more particularly on the application of Web 2.0 tools and differentiated instruction in the development of the writing skill of these two students.

*Keywords:* technology, action research, differentiated instruction, blended learning, Web 2.0 tools, semi-structured interviews

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## Introduction

In recent decades, the proliferation of Information and Communication Technologies (ICTs), as well as the widespread use of the Internet and Web 2.0 tools have shaped a new reality in the field of language teaching and learning. One of the most important and demanding aspects of language teaching is the production of written discourse, where the student is called upon to become actively involved in the process of creating comprehensive and effective texts, to become aware of its mechanisms and to develop self-assessment skills. Since education is not stuck to old traditional methods, but moves ahead, by incorporating new instructional tools, such as Web 2.0 tools, it contributes to the achievement of the best learning outcomes.

Therefore, the aim of the present research is to examine the extent to which the application of Web 2.0 tools reinforces the writing skills of EFL students who will be taking the KPG B1 / B2 exam, within a blended learning environment, based on differentiated instruction. The specific study addresses the following research questions:

1. How can the use of Web 2.0 tools motivate students to produce written texts?
2. Is the use of Web 2.0 tools effective for students who want to generate new ideas?
3. Is the use of Web 2.0 tools effective for students who want to plan their writing?
4. Is the use of Web 2.0 tools effective for students who want to enhance their vocabulary use?
5. Did the use of the Web 2.0 tools have a positive effect on students' performance in writing?

## Blended Learning

To begin with, blended learning could be described as the combination of face-to-face teaching with computer-mediated instruction (Singh & Reed, 2001; Graham et al., 2003; Graham, 2006; Garrison & Vaughn, 2008). Learning is viewed as an active process, in which the students, with guidance, create their own meaning (Baumgartner et al., 2003). The student learns partially online and has some control over the time, place and pace of learning (Maxwell, 2016). According to Gray (2004), blended learning combines traditional learning methods with new technology, resulting in the creation of a collaborative and dynamic learning framework, as students are given the opportunity to learn, working with engaging and rich online material. To add to this, blended learning has the potential to become more effective than the traditional classroom model (Heterick & Twigg, 2003) and mixed lessons are becoming increasingly important, with information and communication technologies developed to complement rather than replace traditional forms of learning (Mitchell & Forer, 2010).

### **Differentiated Instruction**

Differentiated instruction is the adaptation of each lesson to fit each student's specific and unique needs (Spencer-Northey, 2005). The students' view on how they prefer to work is considered of paramount importance (Tomlinson, 2003) and their interests and likes are seriously taken into account when structuring the lesson (Tomlinson & Imbeau, 2010).

Instant learning, the satisfaction of students involved in it and the dedication to special learning needs, taking into account the students' learning level, have been the initial components of definitions which were presented for differentiated instruction. (Ernest, Thompson, Heckaman, Hull, & Yates, 2011). Differentiated instruction is a proven practice for researchers to increase students' engagement and interaction through a combination of activities and materials, and can be tailored to each student's individual needs. (Abbati, 2012). Tomlinson (2001) highlights the choice of teaching techniques that will support more and more classes of students, while Kapusnick and Hauslein (2001) stress the need for students to engage in high-level, organized forms of teaching with teachers accepting its diversity and adapting to their needs.

### **Web 2.0 tools**

The term Web 2.0 tools generally refers to a second generation of services available on the Internet (World Wide Web), the next generation of the Web, the user-generated, social and participatory Web (Dougherty, 2004) which allows students to collaborate and share information online. With the introduction of social networks, blogs and wikis and multimedia sharing sites, the Web becomes an interactive social environment, where knowledge sharing, collaboration and networking are facilitated (Anderson, 2007).

Web 2.0 tools are different ways of creating material and communicating with other users, but they also provide new ways to organize information to facilitate learning. Teaching focuses on the student, since through Web 2.0 tools, knowledge production methods change and students are attracted to activities that are more collaborative. This creates greater opportunities for access, discussion and transparency in the search for knowledge (Conole & Alevizou, 2010).

### **Benefits**

With the use of Web 2.0 tools, the writing lessons are transformed from dull lessons to engaging, interesting and fun lessons (Crane, 2012) and as they offer enriched learning experiences, the students' motivation is enhanced (Godwin-Jones & Murphy-Judy, 2006). Moreover, with the use of Web 2.0 tools, students are encouraged to think critically when they choose information that is relevant to the topic, when they evaluate and compare the information needed and when they share reflections on their work (Warschauer, 2010), leading to the development of their critical thinking and their higher order thinking skills (Richardson, 2010). Furthermore, EFL skills development can be promoted with the use of the Web 2.0 technology. Although there are tools which foster mainly one skill, the teacher can organize the writing lesson in a way that all the skills are integrated and boosted. Additionally, accessing authentic material and resources, enables the students to participate in authentic, real-life tasks and they are also given the opportunity to take part in real communication, as well as to show their work to a real audience (Peachey, 2009). Last but not least, students' autonomy and self-directed learning is fostered, as they are able to study at their own pace, taking control of their own learning.

### **Action research**

Action research in its broadest sense can be defined as "the study of a social situation in order to improve the quality of action" (Elliot, 1991: 69). According to Levin and Rock (2003: 136), "action research is the systematic research of teachers with the aim of practicing their teaching.". As can be seen from the above definitions, the objectives of the action research are outlined in terms of understanding, improvement or change, involvement or participation, functionality, cooperation and self-assessment. Improvement or change refers to three areas: (a) the improvement of a particular educational practice, (b) the improvement of the understanding of this practice by the teachers themselves, and (c) the improvement of the situation in which this practice is set (Robson, 2007). The involvement concerns all those involved in the action research and the practice being investigated. Functionality is promoted, in the sense that the results of action research are immediate and applicable. In addition, collaboration is encouraged between those who research and those who are the focus of research (Robson, 2007). Last but not least, the term self-assessment refers to the flexibility of the project and the ability of the researcher to reflect on all phases of the research, to challenge, evaluate and adapt it to the new data.

### **Qualitative data tools**

Qualitative data resources involve the collection of both descriptive and narrative data, through which the researcher is given a deeper understanding of the phenomenon that is under discussion (Gay et al., 2003). In the particular context, the teacher has collected data through audio recordings, the teacher's diaries, semi-structured interviews and the students' writings.

### **Quantitative data tools**

In the particular intervention, the tool which was used to gather quantitative data was the pre- and post- tests, one of the most commonly used tools for this purpose (Dornyei, 2007). These tests were administered to students so that the effectiveness of the particular intervention, which was the improvement in the writing skill with the use of Web 2.0 tools, could be measured.

### Pre-test and post-test results

In this particular context, the pre-test was administered both to student A and B before the intervention, in order to identify that they were both at the same language level. The pre-test was the writing part of the KPG exam of 2019 and the students' writings revealed that their language level of competence was equal. The same post-tests were administered to both students after the intervention and the same writing part of the KPG exam which was written in 2019 was applied so as to probe into the effect of using Web 2.0 tools in the writing classes of the B1 / B2 levels, in order to check up on the completion of their writing tasks. Comparing the writings of the pre- and post-tests (figure 1 and 2) we see that the differences in the production of speech were more than obvious. Regarding their arguments in the post-tests, they were more substantial than the pre-tests, in which they used more 'childish' arguments which, in most cases, they did not provide examples in support of what they were saying. However, in the post-tests, their arguments were more targeted, supported by examples and clearly arranged in paragraphs. This improvement can be attributed to the fact that students were capable of thinking critically before proceeding with their writing tasks, and were also able to identify their weaknesses and to correct their mistakes. Moreover, in the post-test they revealed more consistent pieces of writing, compared to the pre-tests which illustrated rather disorganized writings. Students' engagement in tasks which focus on the process of writing is essential as their communicative competence is enhanced, which enables them to develop their composing strategies (Drepanioti, 2009) and besides that the students' attitude towards writing was also affected positively (Petraiki, 2008).

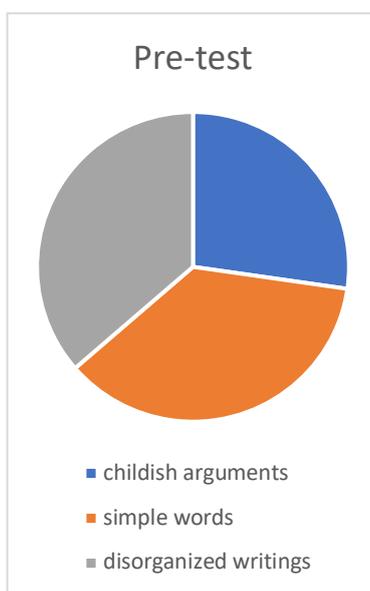


Figure 1

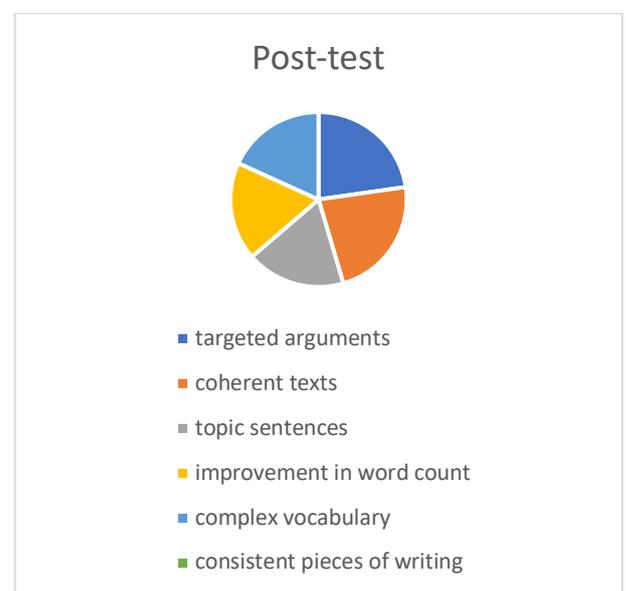


Figure 2

### Pre- and post- semi-structured interviews

The choice of the specific Web 2.0 tools was decided by the teacher, in an effort to support the development of the learners' writing skill in a more learner-centered class. According to Katsara (2008), when the content of the course is relevant to the students' needs, they feel motivated in participating in the class.

Before deciding on the use of Web 2.0 tools, the teacher conducted an initial semi-structured interview, to investigate the preferences of her students and the difficulties they face when they are engaged in writing, so as to adjust the lessons with the use of Web 2.0 tools.

The students expressed their opinion about the production of the writing skill. They both feel that it is difficult to produce written texts (figure 3).

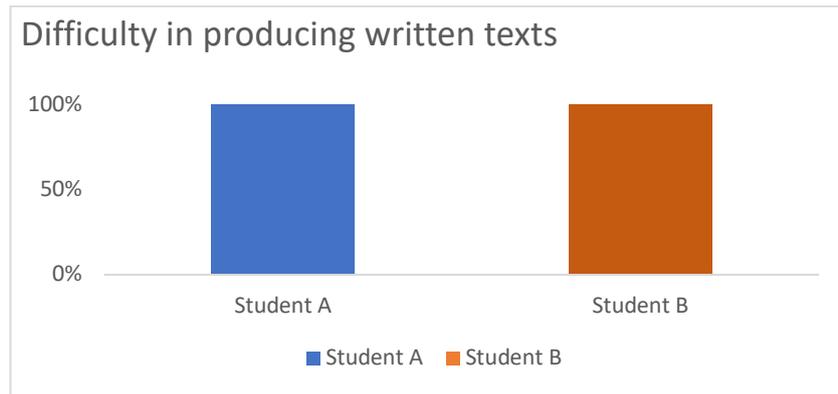


Figure 3

They also expressed their opinion on the exercises they preferred to use in order to practice the different stages of writing, as well as the topics they are inclined to read and write about. Regarding generating ideas (figure 4), the students' responses reveal that the most useful activity is watching videos.

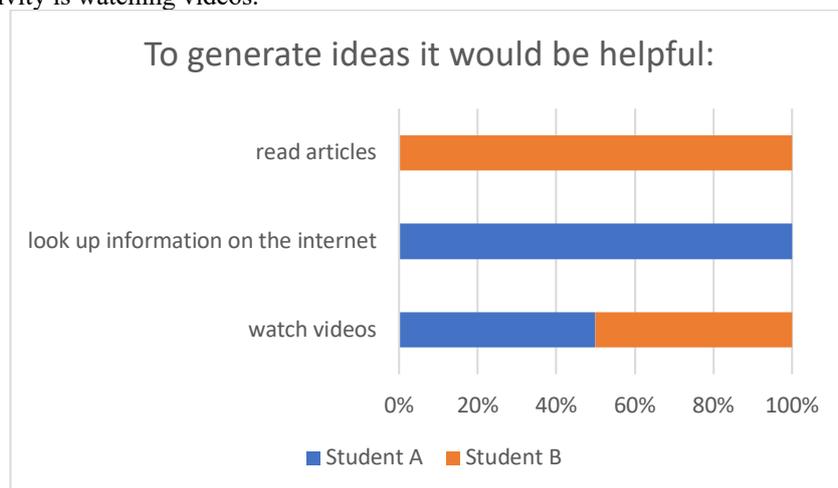


Figure 4

In regard to planning their writing (figure 5), both students expressed their opinion about the exercises they think would be helpful.

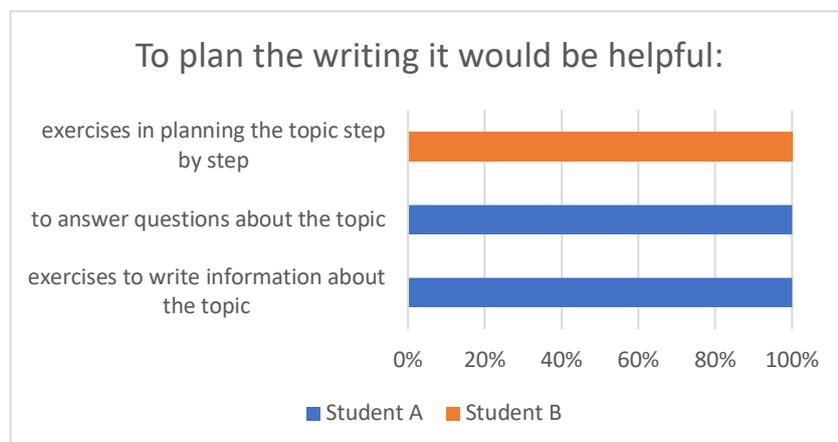


Figure 5

In brainstorming vocabulary (figure 6), they both agreed that a picture, a video and vocabulary exercises would be helpful.

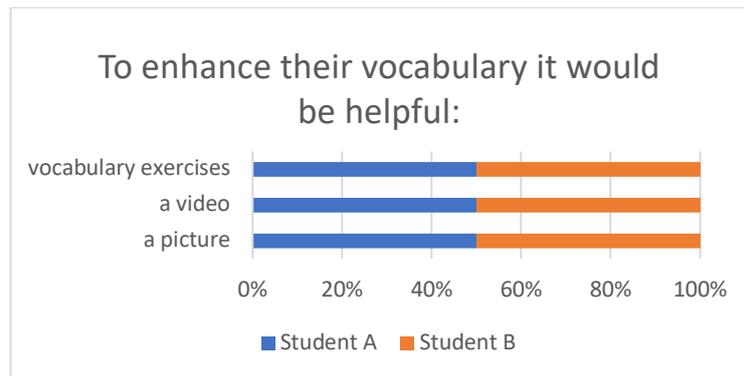


Figure 6

Both students use the internet every day to do exercises, find useful information on the internet, watch videos, to watch a film, to listen to music, to find information and to read news.

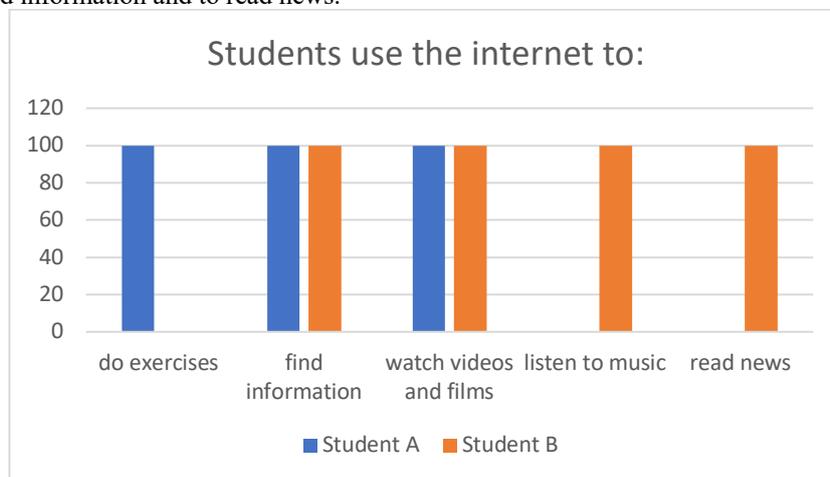


Figure 7

The findings of the final semi-structured interview show that both students enjoyed the fact that they practiced writing with the use of Web 2.0 tools. In addition, it helped them develop themselves, improve in producing written texts and in generating ideas. Concerning planning their writing both students asserted that they have faced no difficulty by using the Web 2.0 tools and the continuous practice they were involved in contributed to their development in this stage of writing. Regarding enhancing their vocabulary with the use of Web 2.0 tools, both students think it was improved through practicing with the Web 2.0 tools. As both students are used to using the computer and the internet on a daily basis, they thought it was easy to use each one of the Web 2.0 tools and to search for information online. In addition, they placed emphasis on the fact that using their computers and the internet during the lessons to complete various activities, made their learning interesting and creative. Moreover, they both expressed their willingness to use Web 2.0 tools again in their English lessons, proving the benefits of using technology in teaching English to EFL students.

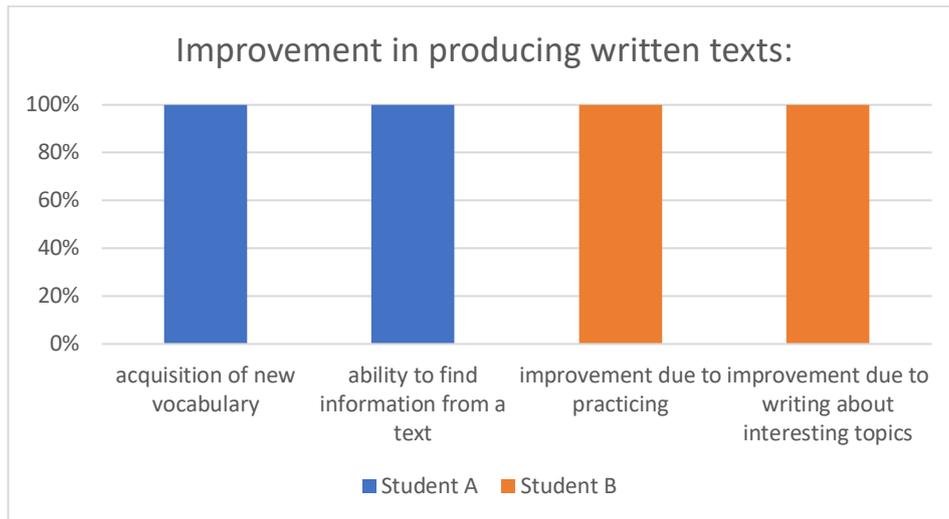


Figure 8

When students were asked whether the blended learning course was beneficial to prepare themselves for the writing tasks, they unanimously agreed that the combination of face-to face tuition with the use of computers and the internet helped them to deal more efficiently with the writing tasks (figure 9).

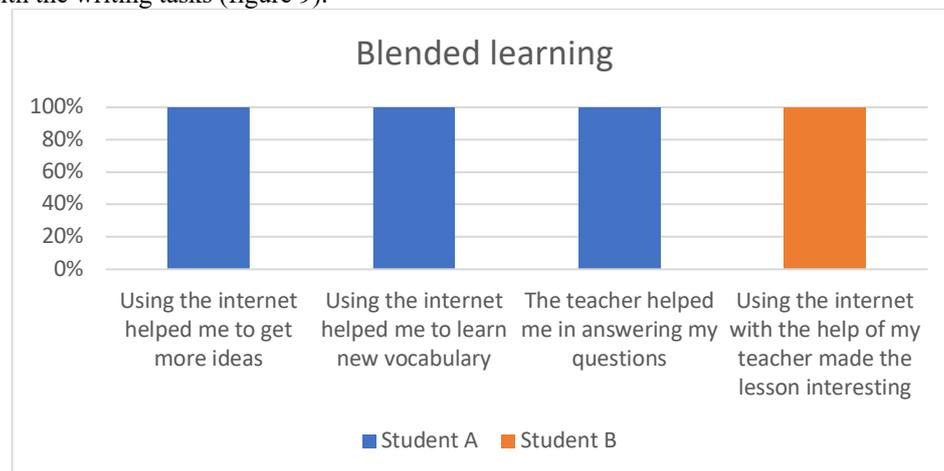


Figure 9

Regarding motivation, both students agreed upon the same fact that through the use of these tools their writing became more creative and the writing process became an interesting and enjoyable experience (figure 10).

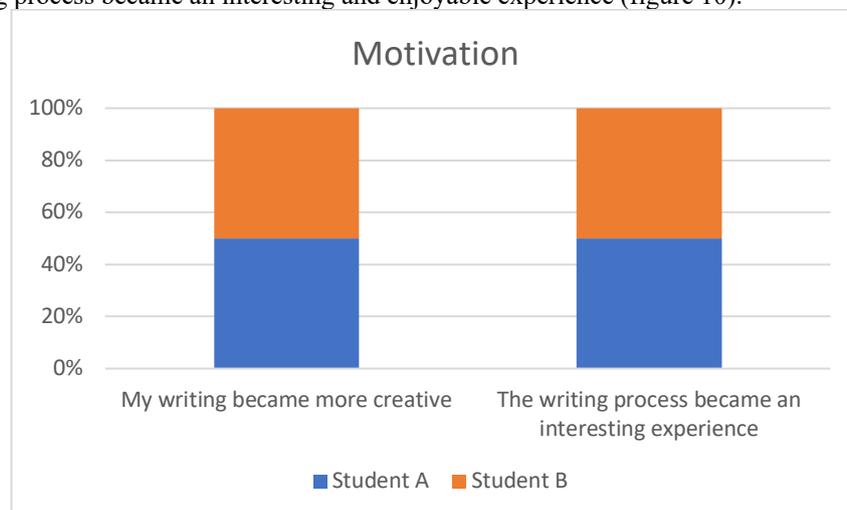


Figure 10

### Students' writings

A closer look at the students' writing reveals that in the first two projects, they paid more attention to content rather than form. Their aim was to get their meaning across and they did not observe any mistakes concerning grammar, spelling, or linking words which were important to use. But, from the third writing lesson, an improvement in the total word count was obvious, as their texts were significantly larger. Additionally, a complexity of ideas was obvious as the lessons progressed, since students were able to write longer sentences in the target language, using a variety of nouns, verbs and adjectives. Apart from that, they used examples to support their opinions, when it was needed, revealing that their performance increased and that their writing skills had evolved. Another fact that was observed regarding the students' progress was their improvement in making decisions on useful information. During the writing lessons, they were exposed to authentic material, such as videos, articles and internet pages and then, they were asked to choose the most important information in order to present it using a particular Web 2.0 tool. So, as the teacher's journal reveals, learners had not fully acquired the necessary skills to process information in order to use it appropriately at first. But as the writing lessons progressed and with the teacher's guidance throughout the process, they developed their critical thinking skills and they were able to collect the appropriate information to use in their writing. Eventually, students felt more confident and willing to be engaged in the writing process, thus the "pervasive impact that anxiety has on the language learning experience" was eliminated (Wei, 2007).

### Limitations of the study

To begin with, the findings of this study are limited since two participants took part in the research. This fact, inevitably shows that the findings of the study are illustrative and that they can neither be generalized nor applied to all teaching contexts, since the particular sample does not represent all students of the same age group, who might have different experiences, likes and preferred methods of learning the English language. Secondly, another limitation concerned the fact that the students were preparing to sit for the KPG B1/B2 exam a couple of months later and their preparation was intensive as they approached the date of the exams. The fact that the intervention consumed part of their weekly lessons, added to their anxiety and negative feelings. Last but not least, a great limitation that had to be dealt with during the teaching of the writing lessons was the threatening situation that our country was facing due to COVID-19. Since schools had closed down and the preventive protective measures that the Greek government had applied in an effort to minimize the spread of the virus, the teaching of the lessons in person were impossible. Hence, half of the teaching lessons were taught online via Skype. Although the lessons took place without any technical problems, it is certain that online teaching cannot substitute face-to-face teaching.

### Suggestions for further research

The particular study added to the body of language pertaining to the effectiveness of using Web 2.0 tools so as to achieve better results in the development of the writing skill and thus language learning. That being the case, it is suggested that future studies, including a larger representative sample, will probably bring more accurate results and attribute greater validity, reliability and in-depth analysis on students' learning and motivation by using Web 2.0 tools. Moreover, a more extensive intervention would give the participants the necessary period of time to adjust and the teacher could benefit from the greater opportunities to collect data. Finally, it would be of great interest to investigate younger learners' attitudes towards a new approach regarding the writing skill, since they will supposedly be more receptive to shifts in teaching methods.

### Conclusion

The current research addressed the issue of the application of a blended learning model in a learner's environment with a view to enhance the students' writing skills via the use of Web 2.0 tools and supplementary material which was designed to enrich the students' preparation for the KPG exam for the B1/B2 levels. The designed material was taught and researched for the purposes of this study and the outcomes indicated the beneficial impact of Web 2.0 based material, when it aligns with differentiated instruction. It has been shown that the incorporation of Web 2.0 tools in teaching can be a factor that can positively affect the students' motivation as well as their performance regarding their writing skills. Concerning the writing skill, it could be said that it created a climate that can be characterized more as conducive to learning and for this reason it facilitated the development of writing strategies.

The final conclusion that could be drawn is that the designed material used in the writing lessons is appropriate and relevant for the purposes for which it was designed and henceforth, its incorporation in the syllabus is recommended, despite the fact that the specific research was a small-scale research study and its results are tentative and definitely not conclusive and generalizable. The particular study was conducted in the hope of contributing to education and more particularly to the EFL context with the use of innovative tools and teaching approaches to teaching.

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# Regulating television viewing amongst teenagers can curb schools' unrest

Mary Njeri Kamaku <sup>\*1</sup>, Prof Helen Mberia<sup>2</sup>, Dr Kyalo Wa Ngula<sup>3</sup>

<sup>1,2,3</sup>*School of Communication and Development Studies, Jomo Kenyatta University of Agriculture and Technology, Kenya*

*1\* Corresponding author: Email: njerikamaku@gmail.com*

## Abstract

Unrests in schools have been used by students over the years as a means to air discontentment with schools' administrations in expressing their grievances. Long exposure to television models that use violence to express anger towards subjects inculcates in the children viewers tendency to emulate. Most governments have stipulated media laws that clearly outline how children should be protected from harmful content. However, implementation of the same is hardly achieved as studies have shown that violent content is aired in masses even in local mainstream stations and worsened by rapid digital arena that gives viewers vast stations to choose from. Unfortunately, most parents are not aware of what their children watch either because they are busy in their careers or hope teenagers are big enough to choose their programs.

The study was informed by social responsibility theory which stipulates that is the role of the law and parents to safeguard from harmful violent content to ensure that they don't grow in aping television models. This study employed descriptive survey design and was carried out in Kiambu County, Kenya involving public secondary schools' students. Stratified sampling was used to get the sample of 398 students to include single sex gender schools and mixed gender schools then random sampling respondents in the selected schools for the quantitative data collection through questionnaires. School administrators in the 7 sampled schools were engaged as respondents for qualitative data through interview guides. Results showed that the television regulating agents had no effect in the unrests in schools implying that parental role and media laws regulation were lacking in moderating the harm caused by violent content thus schools unrest heightening at the expense of poor school grades and destruction of school premises and loss of students lives. Therefore this is an alert to the Ministry of Education to address the grave issue.

*Keywords: Media regulation, Parental mediation, Co-viewing, Harmful media content, Social responsibility*

## 1: INTRODUCTION

### 1.1 Background to the study

Huesmann et.al (2003) conducted a follow-up of a three-year longitudinal study he did together with colleagues in 1977. The initial study included 557 children aged 6 to 10 years from five countries. The investigators collected information on childhood TV-violence viewing, judgements of realism of TV violence, identification with aggressive TV characters, judgments of realism of TV violence, intellectual ability, aggressive behavior, as well as parents' socio-economic status (assessed by the level of educational), parenting practices and attitudes, aggressiveness, and parent's TV usage (that is, frequency of TV-viewing and TV-violence viewing). The study found there was positive correlation between prolonged violent television viewing amongst the children behavior change and that where parental mediation was present this reduced the impact of violent behavior adaptation.

Studies show that parents play an important role in their children's social learning, but if a parent's views are not discussed explicitly with children, the medium may teach and influence by default. Other media, such as magazines, radio, video games, and the Internet, also have the potential to influence children's eating habits, exercise habits, buying habits and mental health. If children are allowed to be exposed to these media without adult supervision, they may have the same deleterious effects as television.

A study by Babita Singh (2013) found widespread frustration amongst students reported from various places. The students, instead of turning out to be a positive force in nation building, are becoming progressively indignant. They show their displeasure by acting against social patterns in a way which perplexes the elders. Consequently, the problem of unrest among students has become not only a cause of worry among administrators in educational facilities but also a national concern.

In a survey study (Parkes, Wight, Hunt, Henderson & Sargent, 2013), 158 dyads of German parents together with their nine to twelve years-old children described their television and video game consumption, parental mediation tactics, and family climate. Parents also stated their beliefs regarding media effects. The result was that mediation approaches differ from accepted media usage conceptions in that parents play a more active role than previously assumed. Restraining mediation includes rules and restrictions, but also parents' educative elucidations that media do not reflect reality. Condescending mediation comprises shared

media consumption, but also parents commenting on media contents. Pointing out and emphasizing socio-emotional features in the media (e.g., empathy) typifies active-emotional course (AEC). Their regression analyses exposed parental fear of adverse media effects projected both AEC and restrictive mediation. Children and parents' congruent discernments of family interactions forecast AEC and patronizing video game mediation. Overall, positive ratings of family interactions were connected to children using media less frequently.

### 1.2 Statement of the problem

Data showing the negative effects of exposure to violence, incongruous sexuality and pugnacious language are convincing and can harm children and adolescents. Children watch violent movies and learn to adopt scripts that use violence as a suitable process of problem-solving. There is a liaison between watching violent television programs and a surge in violent behavior involving children (National Institute of Mental Health (1982). Besides, television watching is known to take time away from reading and schoolwork.

With set media laws already in Kenya it is well assumed that children are protected from harmful media content and more so violent content. Also, with increased need for parents to invest in their children's education it is certain that the former is aggressive in addressing any hinderance to best education and moral values. The question thus to why schools unrest multiply by day led the researcher in this study to find out how much parents and teachers are involved in guiding children against violent media modelling and if they are aware the relevant media regulators are doing little to this and perpetrators of outlined offences go unpunished.

## 2: LITERATURE REVIEW

### 2.1 Television viewing regulating agents

Restrictive mediation; cocooning (Parkes, Wight, Hunt, Henderson & Sargent, 2013) comprises rules or restrictions aimed at sheltering children from the media. Rules may involve, for instance, the amount of time a child is allowed to watch TV or the specific shows that a child is restricted from viewing. For the TV medium, restrictive mediation was found to be the dominating parental strategy in families with younger children and for parents who were afraid of negative media effects (Valkenburg, Krömer, Peters, & Marseille, 2013). Active mediation refers to parents explaining to and discussing media or specific media content with children, such as providing information on news reports, game shows, advertising, educational programming, or video games, but it may also comprise parents' explanations of the difference between reality and fiction. Active mediation increases parental mediation and family processes children's skepticism towards TV content. In addition, parents who are worried about the negative influences of violent content are more likely to engage in conversations with their offspring about media use (Nikken & Jansz, 2006; 2007).

Finally, co-operative mediation (or co-use), which comprises co-viewing and co-playing, is defined as accompanying children's media consumption (e.g., watching television together with the child). Unlike active mediation, co-use does not include explicit discussions. Co-use can be either passive (e.g., when the child enters the room while the parents are watching TV or vice versa) or intentional (e.g., when the parents ask their child to join them watching TV).

Co-viewing does not serve as an indicator describing parental mediation. Parents do not consider it their duty to watch television regularly with their children. They will intervene in viewing situations when necessary, and therefore forms of viewing together which genuinely reflect mediational aims may be very rare indeed. This happens especially with younger children, whose program choices are not seen as problematic by parents, the 'teaching periods' may be limited to a few situations in which it is 'made clear' to the child that the world of fiction is different from reality. In contrast to what is generally believed, the increase of co-viewing with older children does not necessarily reflect a convergence of tastes (Dorr et al. 1989). At least in part, it seems that influencing children's interpretations of programs and the world they portray is at this age the main form of parental mediation when an outright ban on viewing is often too difficult to implement. In the case where a parent refuses to watch a program that he or she considers dubious, the very exceptionality of this decision may be an extremely powerful educational measure.

Parental control does not always mean an absolute ban on viewing. It is clear, however, that programs which on the basis of prior experiences are suspected to have unfavorable effects, will be subjected to special monitoring. These programs are invariably viewed together with children, particular attention is paid to the child's reactions, and parents make clear their own views about the program suggesting that schoolchildren's interpretations of programs are constructed partly in interaction with the parents.

### 2.2 Students' unrest in secondary schools in Kiambu County, Kenya

Education has a sure role to play in the development of people and countries. It has been referred to as one of the most significant determinants of economic growth. It is both a pointer and an instrument of development. Education intensifies labor productivity in both urban and rural sectors, and economic proceeds to investment in education are characteristically high.

A 1994 national investigation in suburban, urban, and rural schools in the United States of America reported two key factors were held responsible for students' unrest that led to school violence. They were not numerous and not limited to the breakdown of the family; and increased portrayal of violence in the media and popular music. Other factors encompassed;

alcohol and drug abuse, and easy access to weapons, such as guns. Poverty and unequal educational opportunities also prompt school youths to violence, Adolescent Health, 2007).

The developing countries have been the chief receptors of students' unrest that has often birthed major violent and destructive consequences (World Bank Statistics, 2012). In Kenya, the year 2016 has been marked with schools' dormitories been set ablaze and property worth millions went to waste over what students felt was an annoying lengthened second term period. The more schools reported to have gone wild the more others were fueled to do the same perhaps not wanting to be left out. In Kenya, the students' unrest behavior has a long history and several pieces of evidence confirm this unfortunate happenings: In Bombolulu Girls Secondary, 57 students perished in dormitory following an arson attack by other students in 1997. On record also is Kyanguli Boys Secondary school in Machakos (2001) where 67 students perished in an inferno which was started by other students in the school in a bid to force the administration to close the school earlier than expected. However, as recent as 2008, schools were hit by a wave of unrests where over "300 secondary schools were hit by unrests that saw students disrupt learning, besides destroying property worth of millions of shillings" (Daily Nation, July 14, 2008, in Kindiki 2009).

The need for a safe and non-violent environment is therefore a necessity for smooth teaching and learning. Lack of discipline in a school creates an environment that can become violent and unsafe. The secondary education system in Kenya has been prone to students' unrest that has not been addressed for a long time and there is thus need to assess the role of television viewing regulating agents in curbing schools unrest.

### 3: RESEARCH METHODS AND MATERIALS

The study population included public secondary schools students in Kiambu County. The choice of this county was based on the rate of reported unrest in schools especially in 2016 during the rampant burning of schools; in Kiambu 6 schools (on record) were engaged in burning of school property (Republic of Kenya, MOEST (2016). A longitudinal study was used thus the researcher increased the chances of TV violent content being singled out as the main risk factor of violent behaviour in the subjects when the behaviour after every exposure became consistent to make a conclusion on the impact.

The 7 schools sampled enabled the researcher to collect detailed data as she was able to administer the research instrument personally with the research assistants. Purposive sampling was also used to select 3 schools that had been involved in unrests in the recent past as (Orodho (2002) argues the researcher looks at a sub-group that is typical of the population as a whole. The schools' stratification was mainly because single-gender schools, as well as boarders and day scholars, are likely to have different experiences on the impact of television in the rise of unrest in schools. In each school, the stratified random sampling technique was used to select the students based on the school population. This sampling implies that the researcher was assured that certain subgroups in the population were represented in the sample in proportion to their numbers in the population (Orodho and Kombo 2002).

The equation below was used to establish the moderating effect of Regulation of violent Television content on the correlation between violent content television programs, TV viewing Duration and Peer Influence in Television viewing had any influence (Independent variables) and student's unrest in secondary schools (dependent variable).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_1 X_1 * M + \beta_2 X_2 * M + \beta_3 X_3 * M + \epsilon \dots\dots\dots (6)$$

Where: M = mediating variable (Regulation of violent Television content)

The final estimated model was:

$$Y = 0.043 + 0.364 X_1 + 0.610 X_2 + 0.308 X_3 - 0.011 MX_1 + 0.049 MX_2 - 0.019 MX_3 \dots\dots (7)$$

Where  $X_1$  = Violent TV viewing programs,  $X_2$  = TV viewing duration,  $X_3$  = Peer Influence.  $MX_1$ ,  $MX_2$  and  $MX_3$  are the interaction terms between Regulations of violent TV content and the independent variables.

## 4: RESULTS AND DISCUSSION

### 4.1 Descriptive analysis for Television viewing regulating agents

**Table 1: Descriptive analysis for regulating agents of television viewing**

Regulation of violent Television Content	SA (%)	A (%)	N (%)	D (%)	SD (%)	Mean	SD
There are TV programs I watch in the absence of your parents	92(26.9)	169(49.4)	7(2)	39(11.4)	35(10.2)	2.29	1.261
Secular music	65(19)	145(42.4)	10(2.9)	28(8.2)	94(27.5)	2.83	1.531
Horror movies	60(17.5)	143(41.8)	6(1.8)	29(8.5)	104(30.4)	2.92	1.556
News	41(12)	65(19)	19(5.6)	87(25.4)	130(38)	3.58	1.452
Any program rated PG	47(13.7)	121(35.4)	20(5.8)	53(15.5)	101(29.5)	3.12	1.494
My parents give me guidance for programs rated PG?	78(22.8)	103(30.1)	21(6.1)	84(24.6)	56(16.4)	3.01	3.329
I trust what my parents say about the content?	96(28.1)	107(31.3)	47(13.7)	57(16.7)	35(10.2)	2.50	1.328
Compared to peers' guidance, parental guidance is more real and helpful?	146(42.7)	115(33.6)	23(6.7)	39(11.4)	19(5.6)	2.04	1.206
I think most parents are aware of what adolescents watch	86(25.1)	122(35.7)	32(9.4)	73(21.3)	29(8.5)	2.57	1.669
Parents' ignorance of programs watched by adolescents can be attributed to Busy work schedules	72(21.1)	145(42.4)	23(6.7)	42(12.3)	60(17.5)	2.63	1.399
Trust on adolescents making right choices	147(13.7)	122(35.7)	39(11.4)	69(20.2)	65(19)	2.95	1.368
Different TV viewing preferences	61(17.8)	143(41.8)	31(9.1)	49(14.3)	58(17)	2.71	1.369
I relate well with my parents or guardians?	130(38)	143(41.8)	23(6.7)	18(5.3)	28(8.2)	2.04	1.182
They like me very much	121(35.4)	131(38.3)	19(5.6)	22(6.4)	49(14.3)	2.26	1.376
They fairly like me	42(12.3)	104(30.4)	25(7.3)	75(21.9)	96(28.1)	3.23	1.446
They do not like me	17(5)	33(9.6)	12(3.5)	95(27.8)	185(54.1)	4.16	1.178
The television programs I access violent content from are always rated PG	59(17.3)	93(27.2)	26(7.6)	108(31.6)	56(16.4)	3.03	1.392
There are some programs that are aired before 10pm that contain violent content	62(18.1)	148(43.3)	32(9.4)	50(14.6)	50(14.6)	2.64	1.329
Alcohol and cigarettes adverts are aired on television	85(24.9)	168(49.1)	22(6.4)	35(10.2)	32(9.4)	2.30	1.216
Programs rated for general viewing contain violent content	49(14.3)	93(27.2)	36(10.5)	90(26.3)	74(21.6)	3.14	1.400

Local programs rate violent content programs unlike western programs	39(11.4)	75(21.9)	39(11.4)	122(35.7)	67(19.6)	3.30	1.315
Secular music shows are not rated PG yet they contain violent content	69(20.2)	142(41.5)	33(9.6)	54(15.8)	44(12.9)	2.60	1.318

The results in table 1 showed that 35.7% of the respondents said that parent's ignorance of programs watched by adolescents is being attributed to trust on adolescents making right choices. 41.8% of the respondents agreed that they relate well with their parents or guardians, 38% of the respondents strongly agreed. This indicates that most parents have good relations with their teenage children and can, therefore, guide them in the television content they view and help them interpret it and separate virtual from the real world.

Out of the program being aired before 10 pm, 43.3% of the respondents agreed that they contained violent contents 18.1% strongly agreed that they contain violent content. This indicates that the watershed period requirement by media laws is not adhered to and children are exposed to violent content contrary to the law.

Alcohol and cigarettes adverts being aired on television was considered and 49.1% of the respondents agreed that alcohol and cigarettes advert are being aired on television, 24.9% strongly agreed, 10.2% disagreed, 9.4% strongly disagreed and 6.4% of the respondents neither agreed or disagreed. These adverts influence the teenagers to engage in drugs abuse and consequently school unrests as the model the TV celebrities to taste various brands. This should worry the society to weigh what is of more value as companies thrive at the expense of developing drugs and substance abuse humans who engage in school unrests consequently with disastrous consequences.

Slightly more than a third (31.6%) of the respondents disagreed that the television programs they access violent content from are always rated PG, 27.2% agreed, 17.3% strongly agreed, Asked if the programs rated for general viewing contain violent content, 27.2% of the respondents agreed, 14.3% strongly agreed and 10.5% of the respondents neither agreed nor disagreed. About 36% of the respondents disagreed that the local programs rate violent content programs unlike western programs, 21.9% of the respondents agreed strongly agreed. 41.5% of the respondents agreed that secular music shows are not rated PG yet they contain violent content, 20.2% strongly agreed, This shows that media regulators have a lot to do to ensure all violent programs are well k8rated so that parents are keen in guiding children where necessary and children are also aware what content is not meant for them. The reason being that most violent programs as shown in the findings are not well rated and media houses get away with it and teenagers receive the content assuming it is for the general public and something to identify with in shaping their characters.

Many school's administrators, whereas admitting the presence of guidance and counselling department in their schools, reported that there is no specific forum where the students are guided in regard to the content they watch on TV. Few, however, said that such guidance is alluded to during class meetings, dorm meetings and interactive talks with teachers as well as during pastoral counselling sessions. Some reported that students are guided on TV watching during assemblies, life skills lessons and during class time. In relation to teachers' involvement in offering guidance on television viewing, many administrators said it is passive during lessons or class meetings. Most reported that TV viewing is restricted.

On the parents' role, many of the interview respondents agreed that parents are not doing enough in offering substantive guidance on television viewing to their children. They attributed this failure to absent parents who are very busy trying to eke out a living hence lacking time for their children. Few reported that parents are ignorant of what their children watch on TV thereby not being able to provide the much-needed guidance. Some argued that some parents do not even care what their children watch.

On the Communications Authority role in regulating TV content, many of the interview respondents reported that it is not doing enough. Few agreed that the authority has tried but needs to improve on its regulatory role. Many were of the opinion that there are programs, especially containing violent content, that need to be censored. They argued that there is too much negative content aired on TV.

#### 4.2 Descriptive analysis for student's unrest in secondary schools

Most administrators agreed that television violence to some extent contributes to unrests in schools. They argued that students are influenced to copy what they see on TV. They postulated that most of this influence comes from the programs they watch at home since at school television viewing is restricted. Apart from television violence, many said that reports from other media forms such as newspapers grapevine on waves of unrests influence the students to be part of what was happening. They also alluded to other factors, for instance, misgivings about the school, being possible causes of unrests in schools.

#### 4.3 Regression Analysis

**H04: There is no statistically significant moderating effect of regulating agents of TV viewing on the influence of the independent variables on the dependent variable.**

Table 2 shows the Model summary Table which presents the results of the coefficient of determination ( $R^2$ ) and the  $R^2$  change.  $R^2$  change shows the rise in deviation explained by adding an interaction term. Therefore, an increase of 0.1% in the variation of

Student's unrest in secondary schools in Kenya was explained by the addition of interaction terms. However, the increase was found to be statistically insignificant ( $F(3,335) = 0.272$ ,  $p=0.846$ ) as the p-value was greater than the 0.05 significance level.

**Table 2: Model Summary**

Model	R	R Square	Adjusted Square	R Std. The error of the Estimate	Change Statistics				
					R Change	Square F Change	df1	df2	Sig. F Change
1	.933 <sup>a</sup>	.870	.869	.31948	.870	755.665	3	338	.000
2	.933 <sup>b</sup>	.871	.868	.32051	.001	.272	3	335	.846

a. Predictors: (Constant), Peer Influence in TV viewing, Violent TV programs, TV viewing Duration

b. Predictors: (Constant), Peer Influence in TV viewing, Violent TV programs, TV viewing Duration, MX3, MX1, MX2

The model coefficient in table 3 shows the significance of the interaction terms and also provides important information about the difference the groups of the moderator in its relationship between the dependent and the independent variables.

**Table 3: Coefficients**

Model		Unstandardized Coefficients		Standardized Coefficients Beta	T	Sig.
		B	Std. Error			
1	(Constant)	.045	.094		.479	.632
	X1	.332	.019	.407	17.567	.000
	X2	.749	.039	.517	19.337	.000
	X3	.253	.030	.202	8.504	.000
2	(Constant)	.043	.096		.450	.653
	X1	.364	.079	.447	4.633	.000
	X2	.610	.160	.422	3.805	.000
	X3	.308	.101	.246	3.042	.003
	MX1	-.011	.026	-.054	-.430	.668
	MX2	.049	.055	.146	.888	.375
	MX3	-.019	.033	-.083	-.574	.566

a. Dependent Variable: Students Unrest

From table 3 the regression equation is as follows:

$$Y = 0.043 + 0.364 X1 + 0.610 X2 + 0.308 X3 - 0.011 MX1 + 0.049 MX2 - 0.019 MX3$$

Where X1 = Violent TV viewing programs, X2 = TV viewing duration, X3 = Peer Influence. MX1, MX2 and MX3 are the interaction terms between Regulating agents of TV viewing and the independent variables.

The interaction terms of all the variables were found to be statistically insignificant. This was indicated by p-values above 0.05 significance level.

Therefore, the hypothesis is not rejected concluding that there is no statistically significant moderating effect of regulating agents of TV viewing on the influence of the independent variables on the dependent variable. This implies that the parents have not taken their responsibility in regulating violent television content thus not being a moderating factor in students' unrest. Therefore, the unrests have risen as parents have failed in their mandate.

The existence of media strict laws in the nation and well-stipulated penalties of any media crime like airing children offensive content, alcohol, and substances abuse and disregard of watershed programs before 10 pm has not helped much in protecting children against such content.

## 5: Summary and conclusions

Out of the programs being aired before 10 pm, 43.3% of the respondents agreed that they contain violent content, 18.1% strongly agreed that they contain violent content. 49.1% of the respondents agreed that alcohol and cigarettes adverts are being aired on television while 24.9% strongly agreed. The programs rated for general viewing contain violent content, 27.2% of the respondents agreed with the claim while 14.3% strongly agreed. 21.9% of the respondents agreed that the local programs rate violent content programs unlike western programs, 11.4% of the respondents strongly agreed. 41.5% of the respondents agreed that secular music shows are not rated PG yet they contain violent content, 20.2% strongly agreed.

The findings show that violent programs are run across local and western television shows and the ratings hardly following the guidelines as stipulated in the media laws. The parents that would moderate the content by giving adequate guidance like separating real and virtual world, raising eyebrows to the Communication Authority of Kenya in programs censorship, are not taking up this responsibility. This implied that the moderating effect can only have an effect on the students' unrest if parents mediate since as the study observed there was no such effect since parents were not doing much thus the unrests are still high.

The study also concluded that the media regulating agents that are supposed to monitor what teenagers watch on television are not doing much. There are existing media laws but implementation is so poor that violent content is exposed to teenagers aired by different television stations even against the watershed period; before 10 pm. Parental moderation is key to teenagers' interpretation of television content especially violent content and also censoring of programs that can influence negatively in inculcating violence in the growing minds. However, most parents are not present and thus their intervention is not well felt; this calling for parental awareness of what their teenage children are exposed and accustomed to.

In totality, the country has continued to experience unrests in secondary schools that could be minimized if teenage television viewing habits were monitored sparing the nation so many losses from the unrest especially burnings of school property, lives and education quality.

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# Analysis of agricultural sector in V4 countries

**Dominika Varga Oravcová**

*Department of Economics, Faculty of Economics, Technical University of Košice, Slovakia  
Corresponding Author: e-mail: dominika.varga.oravcova@tuke.sk*

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## Abstract

The agricultural sector in the Visegrad Four countries has its own specifics and its position has changed significantly compared to the previous socialist system. Moreover, the transformation of processes of agricultural and food production of Visegrad Four countries brought many changes in the area of the material and production base in the agri-food sector, the arrival of foreign investors, the creation of new organisational structures, a change in the production specification of farms through to a drastic decline in the number of workers in the agricultural sector. The paper is devoted to an analysis of the changes and effect of agricultural sector on employment creation in Visegrad Four countries. Our analysis is based on input-output model using input-output tables from WIOD database. The results indicate a declining trend of workers in all analysed countries in the period. The results show significant declining multiplier effect on job creation although the position of agricultural sector in V4 countries (mainly in Poland).

*Keywords:* agricultural sector, employment multiplier, input-output analysis, Visegrad Four countries.

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## 1. Introduction

Transformation in processes of agricultural and food production affected all areas of the material and production base in the agri-food sector from ownership relations to the concentration of production, the emergence of various large companies, the arrival of foreign investors, the emergence of new organisational structures, a refocusing of the production specification of farms through to a relatively drastic decline in the number of workers in the agricultural sector.

The accession of the Visegrad Four (V4) countries to the EU brought about a mayor change in the business environment in agricultural sector, in particular access to the large EU agri-food market and the creation of a challenging and competitive environment. Moreover, the transition period also affected other industries, particularly the automotive sector. Many foreign investments were directed mainly to car manufacturing in V4 countries. The question arises what is the economic effect of the agro sector on the domestic performance of these countries? Have the economic effects on the domestic economy been weakened because of structural changes in these countries? What is the recent impact of agricultural sector on employment of V4 countries? These questions can be resolved via input-output analysis. The aim of this article is to investigate structural changes in agricultural sector focusing on employment in V4 countries. We will analyse the employment multipliers using data from World Input–Output Database (WIOD) covering period 2000-2014. The paper is divided into four sections. Following the introduction, the relevant empirical literature is reviewed in Section 1. Section 2 provides an overview of input-output model that we use to calculate the values of employment multipliers. Section 3 provides results of input-output analysis for agricultural sector. Finally, concluding remarks are made in Section 4.

## 2. Literature review

Several authors have dealt with the analysis and evaluation of the development of agriculture in V4 countries and other EU countries from different perspectives. The emphasis was mainly on development trends in the industry, the continuing disparity of results of agricultural enterprises between the EU countries, segmentation of the countries according to the industry or farm performance and so on. The development and current performance itself of an average V4 farm remains poorly studied.

Svatoš (2008) evaluated the dynamics of the formation of European agriculture, the role of the Common Agricultural Policy and the impacts of agrarian markets on the orientation of the production of individual countries including the V4 countries. Jambor et al. (2016) evaluated the agricultural development of countries that joined the EU between 2004 and 2014. They quantified the performance of individual countries using the method of parallel factor analysis. They noted that after joining the EU, only Poland, Estonia and Lithuania increased their performance. In the other new countries, performance stagnated or declined. As a basis for improvement, they identified the production of agrarian and food products with higher added value and focus on the necessary development strategies. Countries that will focus solely on the production of agrarian raw materials will fall behind.

Jašová et al. (2016) addressed the impact of institutional factors such as employment on minimum wage, wage bargaining structure, active employment policy, tax burden on labour and others on the development of structural unemployment in the V4

countries. They characterised differences in the influence of these factors on the development of unemployment in the countries of this group.

Blaas (2013) compared the performance of the food industry in different EU countries. Authors noted that Slovakia is among the countries with the lowest share of the food industry in industrial employment not only compared to countries regarded as agrarian, but also in comparison to developed countries such as Belgium or the Netherlands. This limits the creation of higher added value for our entire agri-food industry.

Bednarikova (2012) analysed the contribution of agriculture for the economy of rural Vysocina Region. An increase of agricultural production has not underlying influence on total regional production; however, it can positively affect regional incomes. The reduction of agricultural activities could lead to significant losses in income and employment in agriculture and consequential sectors and inhibit regional development. The strong relationship between agriculture and food processing industry can increase regional income and employment subsequently. Machinery, basic metals, construction, tourism, and food processing industry play the significant role in the economic structure and can contribute to an increase of income, employment, and production in Vysocina Region.

Lacina and Minařík (2002) identified the relations between sectorial total production and employment at the level of territorial units of the Czech Republic, and to verify the actual existence or non-existence of these relations. The authors found out that there is a high degree of dependence between the share of agricultural employment and the GDP per inhabitant generated in the agricultural sector.

Olczyk (2011) analyses the structure of Polish economy using three input-output tables to identify the key sectors. The agricultural sector as the leader in 1995, 2000, 2004. Thus, the agriculture, although it loses its position in generating the economic growth in Poland and in creating the value added in the polish economy is still strongly linked with other sectors.

Hamza (2017) looked at the employment situation of the agricultural sector, the identification of factors affecting employment and the examination of potential job creation in the sector. By comparing the three countries, the Czech Republic had the most favourable indicators of labour market activity (activity rate, employment, and unemployment rate). The unemployment rate is the highest in Slovakia, but in 2004 there was a decrease from 18.1% to 13.2% in 2014. The number of unemployed fell from 480,000 in 2004 to 358,000 in 2014. The overall unemployment rate in Slovakia is still high compared to neighbouring countries and the EU average.

### 3. Methodology

Nowadays, increasing attention has been paid to inter-sectorial links with regards to the identifying key sectors that have been important for economic development and growth of the country since the 1950s. Leontief was the first to study structural changes in a selected economy through input-output analysis (Leontief 1953). In empirical literature, we can often encounter an input-output analysis based on the use of input-output tables that provide information on inter-sectorial flows, value added and economic growth (Backer and Miroudot 2014). Input-output framework evaluates two kinds of economic linkages between sectors, i.e. backward linkages, representing demand side, and forward linkages, representing supply side (Lábaj 2014) that allow to identify the most important sectors in the economy. Using the demand-side model, different kinds of IO multipliers can be generated (Miller and Blair, 2009). The most frequently used types of multipliers are those that estimate the effects of exogenous changes on outputs, income, employment, and the value added (Miller and Blair 2009).

Standard input-output analysis is typically made for one country or region where foreign countries are represented by import and export. Leontief's input-output model for one region assumes the division of the economy into the  $n$  sectors, with the output of each sector being used to satisfy final demand or used as an intermediate product. Country's gross output can be expressed as column vector:

$$X = \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} \quad (1)$$

The  $y_i$  variable will determine the final use of a particular consumption object, and the vector captures the values of the final use of individual consumptions.

$$Y = \begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix} \quad (2)$$

The total production can be characterised as the sum of final use and intermediate consumption. The  $Z$  matrix captures the transfer of inputs between sectors within a single economy and takes the form of:

$$Z = \begin{bmatrix} z_{11} & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{n1} & \cdots & z_{nn} \end{bmatrix} \quad (3)$$

The total output of each sector can be registered in the form of:

$$\begin{aligned} x_1 &= z_{11} + z_{12} + \cdots + z_{1n} + y_1 \\ &\vdots \\ x_n &= z_{n1} + z_{n2} + \cdots + z_{nn} + y_n \end{aligned} \quad (4)$$

From the intermediate input matrix  $Z$ , it is possible to calculate the matrix of technical coefficients noted as  $A$ . The matrix of technical coefficient determines the structure and volume of direct inputs of different commodities to produce one unit of production in the sector  $j$ . The individual elements of the matrix  $A$  are noted as  $a_{ij}$  and are calculated as follow:

$$a_{ij} = \frac{z_{ij}}{x_j} \quad (5)$$

The technical coefficients matrix can be written as:

$$A = Z(x)^{-1} \quad (6)$$

Using equivalent adjustments, we calculate Leontief's inverse matrix  $L$ :

$$X = (I - A)^{-1}Y = LY \quad (7)$$

The Leontief matrix is expressed as  $L = (I - A)^{-1}$  and  $I$  represents a unit matrix ( $n \times n$ ). If we sum the elements in the individual columns of the matrix  $L$ , we obtain a line vector of production multipliers. The vertical sum of the elements of the matrix  $L$  indicates how much total production is needed to supply one unit for final use.

The extension of the employment model allows us to analyse the direct and indirect effects on employment in the Slovak economy. Initially, we divide the number of employees of sector by the total production of the sector ( $x_n$ ) and we obtain the unit vector of the direct employment coefficients  $E$ . To find the matrix of employment cumulative coefficients it is necessary to multiply the unit vector of direct employment coefficients  $E$  with Leontief inverse matrix  $L$  that can be written as:

$$EL = \begin{bmatrix} e_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & e_n \end{bmatrix} \times \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix} \quad (8)$$

The individual elements of the  $EL$  matrix represent directly and indirectly generated employment in a sector caused by one final-use unit of the commodity. The multiplier of the employment is then calculated as the corresponding column sum of the matrix elements. The employment multiplier reflects the employment that generates one final consumption unit of the  $n$ -th commodity. Multiplying the matrix  $EL$  by parts of final demand - export  $x$  ( $n \times 1$ ), or domestic demand  $d$  ( $n \times 1$ ), we obtain the direct and indirect employment generated by export -  $ELx$ ; or domestic demand -  $ELd$ .

#### 4. Results and discussion

The basic source of data for our analysis was the WIOD database. We used the WIOD database to construct the input-output model and employment multipliers. Our analysis uses national input-output tables that are based on national accounting and captures cross-sector flows. These tables are published every 5 years. The latest update of socio-economic database was published in February 2018 and contains data for the period 2000-2014. From a structural point of view on economic changes, the results are still actual, as structural changes are not so dynamic.

#### 4.1 Results of employment indicators

The V4 countries, except for Poland, are among the smaller countries in the EU. In 2015, V4 production accounted for only 19.9% of the EU-28 production. The agricultural performance of the V4 countries in terms of output indicators, which includes producer prices excluding taxes and including subsidies in the individual countries has not changed much in the individual countries in recent years with the exception of the Czech Republic in 2015, where the output grew year-to-year by 57%. Output in the Slovak agricultural sector has been stagnating or falling. The V4 countries also considerably lag the EU average in farm gross income. Slovakia and the Czech Republic, on the other hand, significantly reduced the workers per 100 ha of agricultural area leading to growth in productivity. In the amount of subsidies per unit of land Slovakia still lags behind the EU average, but Hungary and the Czech Republic already exceed it.

As regards employment in the V4 countries, agricultural sector despite its growth over the last decade, has experienced almost 50% of the loss of workers in Hungary and Poland. These significant changes in total output or employment were associated with the preparation and later accession to the European Union and the adoption of the EU Common Agricultural Policy (CAP) by the new member states. This policy significantly influences national agricultural policies.

The development of wages, expressed as compensation per hour worked, is indicated in euro in "Table 1". The income of agricultural workers is traditionally lower than in manufacturing and services sectors. Over the period of 14 years, the level of compensation in this sector has increased significantly and the compensations are approximately at the same level.

**Table 1** Compensation of employees per hour of work in agricultural sector in 2014

Country	Compensation per hour in EUR	Growth rate (%) 2000-2014
<b>SVK</b>	6.31	142
<b>SVK National Average</b>	10.8	120
<b>HU</b>	5.23	244
<b>HU National Average</b>	7.47	118
<b>PL</b>	5.96	123
<b>PL National Average</b>	6.65	64
<b>CZ</b>	6.28	82
<b>CZ National Average</b>	9.44	89

#### 4.2 Results of employment multipliers

The input-output analysis allows us to determine structural links between sectorial final demand changes and employment (job) creation. The aim of the analysis is to examine the effects on jobs (physical) creation. Using employment multipliers we examine how one unit output increase due to changes in agricultural final demand will affect creation of new jobs in whole economy (all sectors) i.e. number of jobs generated by growth of sectoral output by 1 000 000 of monetary units.

**Table 2** Employment multipliers (Number of jobs created by growth of sectoral output by 1 000 000 USD)

A01	2000	2007	2008	2010	2012	2014
<b>PL</b>	288	92	79	91	73	67
<b>HU</b>	139	39	32	42	35	32
<b>CZ</b>	84	30	24	31	24	24
<b>SVK</b>	85	19	15	19	14	12

All employment multipliers recorded a decline in values during period 2000 – 2014. One of the main reasons was an increase in innovation and automatization of production and the impact of the crisis consequences. As mentioned, the agricultural sector is the leader sector in Poland and Hungary, although, it lost its position in generating the economic growth in these predominantly agricultural regions. The Czech and Slovak agricultural sectors have passed significant reductions of agricultural employment too. The multiplier effect of studied sectors for employment remains less pronounced in these countries. Interestingly, the values of multiplier in the agricultural sector are remarkably on the same level as manufactured sector C29. It means that agricultural sector generates almost the same number of jobs than automotive C29 sector which is the dominant sector in these countries.

The following section points out to what part of total employment is generated by components of final demand – domestic demand and export ("Table 3"). Employment generated by domestic demand is most pronounced within agricultural sector (A01) particularly in Poland. It is domestic demand that determines the employment creation despite its long-term decline (more than 1 mil. jobs).

**Table 3** Employment generated by domestic demand and export for agricultural sector in V4 countries

Employment generated by domestic demand						
A01	2000	2007	2008	2010	2012	2014
<b>PL</b>	2565	1675	1660	1394	1285	1037
<b>HU</b>	365	166	143	111	102	106
<b>CZ</b>	139	82	83	75	74	71
<b>SVK</b>	82	36	36	30	25	30
Employment generated by export						
<b>PL</b>	362	483	468	541	581	603
<b>HU</b>	144	132	133	159	168	151
<b>CZ</b>	47	56	55	56	66	71
<b>SVK</b>	11	20	19	18	22	18

The entrance of the Czech Republic to the European Union has brought several other problems which farmers must deal with. According to Věžník et al. (2013) corporate farms perceive the greatest barrier to development to be the low protection level of the domestic agricultural products market, and problems with purchasers and their payments. Private farmers perceive administration problems and lack of a processing capacity as the biggest barrier to development. These reasons lead to a loss of job creation in domestic demand in the Czech Republic in recent years.

As regards the Hungarian agricultural sector, it had no political problems before the political and economic transition. The problem occurred in the privatization and inconsistent production structure, which led to a rapid decline in domestic food processing and retailing. Hungarian domestic producers suffered great losses in the domestic production as well as employment which is also reflected in decreasing employment multiplier effect.

The results of our analysis show that the impact of domestic demand on job creation is decreasing, on the other hand the export generates more jobs than 14 years ago. We recorded the highest share of export-generated employment, which is particularly apparent in Poland. Poland is currently the 8th largest exporter of agricultural food products in the EU. Poland's accession to the EU was one of the key factors behind the success of the Polish agricultural food product export. As a result, EU member states account for approximately 81 percent of Poland's agriculture and food products export.

## 5. Conclusion

Our analysis of agricultural sector in V4 countries shows significant changes in the analysed period. The income of agricultural workers is traditionally lower, than in manufacturing and services sectors. During the analysed period, the level of compensation in this sector has increased significantly and the level of compensation is approximately at the same level. The agricultural sector is the leader sector in Poland and Hungary, although, it lost its position in generating the economic growth in these predominantly agricultural regions. The multiplier effect is less pronounced in the Czech Republic and Slovakia.

The results point to the decreasing impact of domestic demand on job creation in V4 countries. Poland is number one in generating employment by domestic demand due to the prevalence of small family farms employing family labour force. All analysed countries recorded an increasing trend of export-generated employment where the dominant exporting country is Poland.

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# Space debris and security in space

Andras Edl

*Doctoral School of Military Sciences, National University of Public Service, Budapest, Hungary*

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## Abstract

Modern technology relies on our ability to deploy and operate various spacecraft in orbit. Due to the flaws of early space technology, accidents, occasional negligence and gradually increasing activity, the vicinity of our planet became more and more polluted. The problem of space junk reached such a magnitude that according to some projections a future accident may cause a setback lasting for years or make space travel impossible. Related to this field, we must also mention the natural space debris field which surrounds Earth, ranging from micrometeorites just a few millimeters in diameter to larger objects which cross our planet's path. Naturally, these objects can endanger equipment in space. Nations, research organizations and private corporations try to find solutions and possible counter-measures to tackle these challenges. However, due to the dual-use nature of space technology, tools and methods able to remove or destroy objects near our planet could also damage sensitive military systems, like the GPS. Therefore any such developments and events are examined meticulously by different institutions and sometimes classified as possible anti-satellite weapons (ASAT). The increased investment in space situational awareness (SSA) capabilities shows the growing importance of protecting space assets from natural threats, accidents, or possible adversaries.

*Keywords:* space debris, anti-satellite weapons, GPS, SSA

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## Why is space debris a problem?

In 1998, the failure of the Galaxy-4 communication satellite surprised a lot of Americans. The malfunction caused serious setbacks in the healthcare sector. Hospitals could contact doctors only with great difficulty because their pagers didn't work. The television industry was also affected, as were weather forecasters, even some automatic petrol stations, where customers could not use their credit cards (Usborne 1998). And this was more than 20 years ago when our lives were not dependent on space. At least not in a degree like today. GPS is one of the rather obvious examples to demonstrate such dependency. It allows us to take a turn at the right corner with our car, or find our way as a pedestrian on Google map. Furthermore, it makes possible the usage of ATMs, synchronization of data packages, online banking and advanced weather forecast. Equally mineral detection, high-speed communication, sophisticated global logistics, modern warfare and entertainment are dependent on space. (ESA 2005). Even today's popular dating apps are mostly reliant on space infrastructure. However, it's not just about having a comfortable life or raising the GDP. The global challenges we have to face can't be solved without space. The Sustainable Development Goals of the UN are unattainable without communication or Earth-imaging satellites (Marshall 2017). If we would lose our assets in space the consequences might be catastrophic. Space debris orbiting our planet could be a cause for such an event. Despite their size, smaller debris can inflict considerable damage to satellites, the International Space Station (ISS) or other spacecraft. The number of debris is on the rise while space activity increases, so more junk on a highway witch gets busier by the day.

## How serious is the problem?

If we take a look at the numbers humankind was quite effective in producing space debris since the Soviet Union launched Sputnik on the 4<sup>th</sup> of October 1957. The European Space Agency regularly updates its publicly available space environmental database. According to the latest update on 1<sup>st</sup> of January 2021, we launched about 10 680 objects into space. From those 6250 are still in orbit, but only 3400 still work. The total mass of space objects is more than 9 200 tons. As for debris, we have 34 000 pieces larger than 10 cm; 900 000 between the size of 1 cm to 10 cm; and approximately 128 million pieces between 1 mm and 1 cm (ESA 2021).

Why is the number so high? Regular space activity does produce some kind of waste. Many of them are just small splinters or paint chips. Others originate from spent rocket booster stages, explosions of remaining fuel, collisions or intentional weapons tests. On-orbit fragmentation is not rare. ESA estimates that more than 550 fragmentation events happened until 2021 (ESA 2021). The first major accident happened in 2009 when the inactive Cosmos-2251 and the still functional Iridium-33 shattered each other to hundreds of pieces. A similar event could happen in the future. According to a study conducted in 2019, during an 8 month observation period, there were 28 occasions when objects with a mass greater than 775 kg came so close to each other, that in the case of operational satellites ground team would have ordered an evasion manoeuvre (Nicolls and McKnight 2019).

Large objects are a serious problem, but the sheer number of debris poses an even bigger threat. Because space debris can travel at a speed of 7-10 km/s, a small piece can inflict serious damage as well. In 2006, a spacecraft in Low-Earth Orbit (LEO) had the chance of 17-20% to be hit by a piece of debris. After the Chinese ASAT test in 2007, this number increased to 25-33%. As a consequence of the 2009 accident, this number came close to 40%. In 2013 a Russian calculation put the number between 50-67% (Hall 2014, p. 7). This was bad enough already, however with every new collision the chance for a chain reaction grows. In this scenario, called the Kessler Syndrome, debris generated by an accident will hit another object, creating a new debris cloud, which in turn will hit one or multiple objects, and so on. This process might take years to unfold.

Spacecraft are also endangered by objects and events originating in nature. Meteors, comets, solar activity, high energy particles, radiation or the wide range temperature changes in space could all disrupt equipment deployed in this harsh environment. Engineers have to make sure that spacecraft can withstand most of these effects. Intense solar activity, so-called coronal mass ejections like the 1859 Carrington event would have a devastating effect on the planet's electric grid, even damaging home appliances (Goldsmith 2014). A new analysis predicts that the chance for a severe storm is 4% per year, and for an event matching the magnitude of the Carrington Event is 0.7% per year (Chapman, Horne and Watkins 2020). Meteors are usually rare, but bigger groups like the Leonids or the Perseids can pose a risk not to be taken lightly. Calculations suggest that a satellite with a surface area of 100 square meters has a chance of 2% to be hit by a meteor. Because the speed of Leonids can be 70 km/s a small meteor could destroy a satellite. Near-Earth Objects are classified as dangerous when they have a diameter of at least 140 meters and could get closer to Earth than 7.5 million kilometers (Almár and Galántai 2007). According to NASA's data, no already known asteroid has a chance to hit Earth in the next 100 years. But in every month the research programs discover numerous new NEOs. For instance, only in 2020 December, the NEO list grew by 268 new objects (NASA 2021).

Nature can also help us to some degree. Earth's atmosphere is not constant. In connection with solar activity, it might expand or shrink. So the lower altitudes in space might get cleaned up by the expanded atmosphere. Smaller debris pieces have a larger area to mass ratio, so they are more sensitive to atmospheric drag and their orbit decays faster. However, this is not enough. Space debris is most common in the low-Earth orbits, below 2000 km altitude, but only objects below 600 km enter the atmosphere in a few years. Objects above 1000 km might stay in space for centuries (Gregersen 2020).

### **The weaponization of space**

Needless to say, the armed forces of space powers also have their fair share in space pollution. Satellites were always a useful tool for the military. During the Cold War, the Soviet Union and the United States build a vast nuclear arsenal and systems of mutually assured destruction. Key elements to these defence architectures were missile early-warning satellites, serving as the eyes in the sky, able to detect the enemy's rocket launches. Naturally, both sides experimented how to destroy these assets and blind their opponent. In 1968 the Soviet Union carried out the first successful kinetic ASAT test in history. The United States followed with their test in 1985. Interestingly there were concepts of Kinetic Energy Antisatellite (KE-ASAT) weapons. After destroying the target it would also envelope all the remains in a Teflon sheet (Tyson and Lang 2018, p. 258).

Early on the two sides realized destroying the early-warning satellites would trigger a nuclear war, for the only reason to attacking them would be to gain the advantage in a nuclear conflict. On the other hand, destroying spacecraft which are not part of the nuclear deterrence architecture could provide some benefits and not trigger a nuclear war. This is the reason while current space powers, especially the ones being fully aware of the United States' reliance on space assets pursue such ASAT capabilities. The type of ASAT weapons is not limited only to kinetic weapons, but kinetic types can produce a huge amount of debris. Tests carried out after 2000 were tightly linked to ballistic missile defence systems. Major powers intend to develop and deploy such equipment to counter their adversaries missiles. The applied technology is suitable to target satellites in Low-Earth Orbit (LEO). If the interceptor has the accuracy and the necessary speed there is not much difference between a ballistic missile head or a low orbit satellite (Horváth 2019).

The People's Republic of China made sure that the whole world is aware: they are a force to reckon with in space. China's Fengyun-1C meteorological satellite was destroyed by a Chinese kinetic ASAT weapon on the 11<sup>th</sup> of February 2007. The test was condemned by the international community and regarded as reckless. The reason for that is the generated debris cloud. Due to Fengyun-1C's 860 km altitude, the majority of the debris cloud is still in orbit and will remain there for decades. According to NASA in 2018 there were still 2832 pieces, out of the original 3442, in orbit. The gravity of that incident can be better understood if we consider that in 2018, this weapons test, together with the already mentioned Cosmos-2251 Iridium-33 accident was responsible for 30% of resident space objects (NROs), and 13% of all objects ever catalogued since the beginning of the space age (Orbital Debris Program Office 2018). After the huge international backlash, China modified its approach, and consequential 7 tests (until 2018) were carried out against ballistic missiles or not hitting a target at higher altitudes. No new debris was created and the countries who could condemn China for such tests are also pursuing such goals, therefore China could avert any further criticism (Horváth 2019).

In the following year, the United States carried out a test. The official reason for interception was that the hydrazine fuel tank could survive entering the atmosphere and endanger human lives. Scepticism quickly emerged, and many claimed this is just a cheap excuse for a weapons test. Yet even Russian sources confirmed it was a right move (Oberger 2008). The target satellite was USA-193 a radar reconnaissance satellite of the National Reconnaissance Office (NRO). The satellite broke down just after hours of the launch on 14<sup>th</sup> December 2006. Its orbit started to deteriorate, thus it was an ideal target for such a test. Operation Burnt Frost was carried out on the 21<sup>st</sup> of February 2008. An SM-3 missile fired from the USS Lake Erie (CG-70) guided-missile cruiser destroyed USA-193. According to the Air Force, tasked to monitor space debris at that time, by 27<sup>th</sup> of February 2009 all pieces of debris de-orbited (Wolf 2009).

On the 27th of March 2019, India also carried out an ASAT test, destroying their Microsat-R satellite with a PDV-Mk II missile at an altitude of appr. 280 km. The results were similar to the United States' 2008 Burnt Frost operation. The number of trackable debris was between 250 and 400 right after the test. While most of them, due to the atmospheric drag more prevalent in low altitudes, shortly after the test entered the atmosphere, some pieces reached a higher orbit and will remain there for years (Henry 2019).

However, despite the relative quick decaying of debris into Earth's atmosphere, low-altitude tests can still cause a huge problem. The debris field of the former USA-193 did not remain at the orbit of the target satellite. They had an elliptical path and debris, at some point of their movement, could be found in a range from 147 km perigee (lowest point of orbit) to 2689 km apogee (highest point of orbit). The remnants of USA-193 had conjunctions (flying by within 5km of another object on orbit) with more than 15 satellites and the International Space Station (CelesTrack 2009).

Interestingly a new type of ASAT weapons could arise from the technologies needed to remove debris. Lasers targeted at them could evaporate some of the debris material and slow them down enough so that their orbit will decay, eventually entering Earth's atmosphere (Choi and Pappa 2012). Another possible solution might be satellites which could catch larger objects with a net, or a robotic arm and deorbit them, with the same result. It's easy to understand that these assets can endanger still functioning spacecraft, causing considerable damage to the adversary's capabilities. In January 2020 the Russian Cosmos-2542, a so-called inspector satellite, synchronized its orbit with the American USA-245 reconnaissance satellite and followed it for a longer time. China and the U.S. also conducted similar tests, so the Russians are not the only one to blame (Patel 2020).

### Space Situational Awareness (SSA)

One more key element to solve the problem of space debris has its roots in military applications. Stakeholders have to know what's happening in space. Space Situational Awareness capabilities can provide this information, equally important for governments and private companies. Traditionally governments, especially the armed forces invested in SSA's costly infrastructure, but in recent years private companies or even individuals can provide services or data to expand the tracking database. TruSat for example is a 100% open source database where people can upload their observation data. They only require some basic knowledge, software and a smartphone (TruSat 2021).

Yet, at the moment scientific institutions, like the ones busy in near-Earth object tracking and the armed forces have the most sophisticated SSA installations. Therefore, the loss of the Arecibo radio telescope was a severe blow to global near-Earth object detection and SSA capabilities. The structure could not be repaired after a storm and on the 1<sup>st</sup> of December 2020, the observing platform collapsed and the 305-meter diameter dish sustained considerable damage as well. The National Science Foundation recommends replacing the damaged structure with a modern phased array configuration, containing about 1000 small dishes. The new structure would increase sky coverage by 250% and incorporate a new radar system. The Pentagon would like to use the new facility to strengthen its SSA capabilities as well (Foust 2021).

The Space Surveillance Network (SSN) is operated by the United States. It has multiple bases all around the world and even two satellites. In 2022 the network will expand with a new surveillance satellite called Silent Barker. The SSN keeps watch over more than 27 000 objects in orbit, and they provide valuable data to stakeholders, like satellite operators, NASA and even other governments. The current size of trackable objects supposed to be over 10 centimetres in diameter which is roughly a size of a CubeSat. By 2024 Washington plans to transfer civilian space traffic management to the Commerce Department, so Space Force can focus on security-related space activity (Erwin 2020). The U.S. actively cooperates with allies and partners to get as accurate data as possible. Canada's first-ever satellite, called Saphire, launched in 2013 was designed to provide SSA data, helping to monitor space junk larger than 10 centimetres (Tyson and Lang 2018, p. 354). Germany, France and the European Space Agency are also ready to share data. The other fully functional SSA system is operated by Russia (Lefebvre 2017, pp. 177-179).

There is one more reason to invest in SSA development. In recent years the launch of satellites launched in space increased dramatically. One factor is the already mentioned decrease in launch costs and the plan for huge satellite constellations. But another factor is the manufacturing of CubeSats. These are small satellites with standardized dimensions. Usually, they are measured in Units, which is a 10\*10\*10 cm cube. The most common sizes are 1, 2, 3 or 6 units. The manufacturers also aim to keep the weight to the minimum, so they try to stick to a 1.33 kg / Unit ratio. These small, lightweight spacecraft can be launched as an auxiliary payload for much bigger projects. However, the exponential rise of objects in space heightens the risks as well. The first CubeSat collision already occurred in 2013 and as a result, Ecuador lost its first CubeSat (Dawson 2018, pp. 57-58). Even smaller satellites, called Sprites, were already deployed in space. With only a size of 2.5-3 cm, they are basically just a small circuit board. Using a shoe-box sized CubeSat as a carrier spacecraft 105 of Sprites were deployed on the 18<sup>th</sup> March 2018. As intended a few days later they entered Earth's atmosphere, to avoid adding to the already existing debris problem (Kacapyr 2019). The size of these relatively new satellites makes it necessary to further develop SSA capabilities and not just for military applications.

### Possible solutions & protection

Tracking objects is already a great achievement, but far from enough. This is a global problem and the issue is well known to the UN, but there is no clear global action plan or directive in sight (Tyson and Lang 2018, p. 260). Capable agencies and governments might set an example. In the last days of his administration, Donald Trump signed the National Orbital Debris Research and Development Plan. The document outlines three main areas of debris mitigation. Governments and companies should aim to limit debris generation by design, track and characterize debris, and finally remove or repurpose debris (National Science & Technology Council 2021). The guidelines are clear and other governments have pretty similar ideas.

However, the realization of these ideas is going rather slowly. Most satellite operators simply don't follow these guidelines. They don't move the satellites to so-called graveyard orbits. In addition, they don't seem to de-orbit them at the end of their lifecycle, which supposed to be no longer than 25 years. The global compliance level with the proposed guidelines is below 50%, so there is still a lot to do (Hitchens 2020). Until this behaviour improves we have to rely on moving valuable assets, shield them, or rely on new technologies.

The International Space Station is one of the most valuable assets in space. Building it took 13 years and cost around 150 billion dollars. The structure orbits Earth at appr. 400 km altitude. To keep it there occasional adjustments are needed because the ISS is subject to atmospheric drag. The engines used for these manoeuvres are the ones helping ground control to move the station when there is even a chance of 1 to 10 000 that a piece of debris could hit the station. NASA receives the notifications from Space Force when an object will move through a 50km\*50km\*4km sized box-shaped perimeter set up around the station. Data is then relayed to the ISS ground team and they can decide if the manoeuvre is necessary or not (Hutchinson 2013). One of the close encounters happened in 2013 when object No. 39612, a torn-off piece of thermal shielding, the size of a plate, changed trajectory due to atmospheric expansion. For a while, the SSN system even lost track of it. by the time it reappeared, it was too late to change the orbit of ISS, so they were just hoping for the best and prepared the crew for evacuation. Luckily the debris passed by the station (Khatchadourian 2020). Naturally, satellites have to be moved on a regular basis too, to avoid collisions like the one in 2009.

The most common protection against space debris impacts is robust frame design and passive shields. Just covering space objects in thick metal plating is not effective. First of all, they would be heavy and getting them in orbit would be highly expensive even after the sharp cost reduction for getting one kilogram into space. In the building phase of ISS, the Space Shuttle managed to get 1 kg to space for \$54 500. SpaceX can do that now for \$2 720, but this would be still very expensive for a solid metal shield plate (Jones 2018). The answer is a multi-layered shielding. The speed and material of possible projectiles will determine the most effective technologies. Beyond 4 km/s the impact will break up and melt the projectile. ISS and other sensitive spacecraft use a design called Whipple shield, named by Fred L. Whipple the inventor of the concept. It's made at least of two layers. The outer layer serves as a bumper, which by impact fragments the projectile. The inner layer will only have to deal with these small, slowed down particles. The 'stuffed' version of the shield has additional material between the two layers, like ceramic cloth or other hardened materials (Dasch-O'Meara 2018). Through the application of this technology, shielding is much more effective and much lighter. Yet, estimates say, that about 20 tons, out of the ISS appr. 250-ton weight is shielding (Kalinski 2004). The research is ongoing and institutes are experimenting with new materials (Kevlar, Nextel, Beta) and designs (Honeycomb panel, Foam panel, Transhab, Multi-shock designs, etc.).

Reusability is a great tool to mitigate the number of space junk. As it is well known, SpaceX, Blue Origin and other companies are making progress in the development of reusable rockets. A more advanced solution would be a functioning spaceplane. So far only two functioning versions were built, both by the United States. These were the now-retired Space Shuttle and the Boeing X-37B. The later is still in service. These vehicles require a rocket to get them to space, so they are classified as two-stage vehicles. By return to Earth, they can land on their own and later be reused. A spaceplane which would be able to take off horizontally, reach space and after its mission land on its own has never been made yet. The technological difficulties are immense. The United States together with Great Britain did carry out some promising tests with an engine built by the company Reaction Engines, but designing the plan will be a task for some other company or government institution (Piesing 2021). China also invests heavily in spaceplane projects. According to sources in 2020 autumn they had 7 ongoing research projects for a spaceplane. **Project Téngyún (腾云) initiated in 2016 seems to be the most promising (Deville 2020).**

Innovative private corporations are also interested in space debris removal plans. Apart from space agencies and private corporations, academic institutions also try to figure out how to decrease the number of debris. A decade-old idea came from the Progress and Freedom Foundation proposed an interesting model: Satellite owners had to pay a new tax, to create an Orbital Debris Removal and Recycling Fund. After that international organization would set a base price, which would allow removal companies to start bidding for satellites. After deorbiting the target, companies would receive a reward, paid by the fund. An alternative would be to recycle the debris rich in high-grade aluminium and other materials (Dunstan and Szoka 2010). Yet the efforts so far are limited. A lack of funds might be one reason, but there might be also some hesitation on behalf of the agencies, and wait for somebody else to do the dirty work. Game theory applied to this problem shows that if all the players would choose the 'sit and wait for others' strategy this will result in the system's collapse, a 'tragedy of the commons'. The analysis shows that even removal of some high-risk objects would significantly decrease the chance for a collision (Klima et al. 2016).

Some governments might be ready to pay good money for such services. Such projects are already on the way. In 2020 December ESA finalized a contract worth 86 million euros, with ClearSpace SA a Swiss startup company. The task is to deorbit a payload adapter, which roughly has the size of a smaller satellite. ESA hopes this will help to create a debris-removal market, strengthening European positions in space. The Agency is also giving technical support to ClearSpace. The mission is set to launch in 2025, and the company plans to upgrade its service, so a single spacecraft can de-orbit multiple targets. This would make the service much more cost-effective (Parsonson 2020).

Experts predict that innovation will make debris clean-up missions effective and worthwhile in a short time. Two trends appear to be pushing developments in this direction. The first trend is the growing concern about the possibility of losing space assets. The second trend is the new technologies arising from the interaction between government agencies and the private sector (Pelton 2019, p. 100).

## Conclusion

Unless a major catastrophe happens companies and governments will expand space activity, deploying hundreds of satellites, build new space stations and keep sending missions into deep space, for scientific, economic and security reasons. The space debris problem is one of the challenges of this new era. Avoiding collisions requires a lot of resources already and an accident could have catastrophic consequences. If left unaddressed the problem will grow, damage valuable equipment, harm economies and endanger human lives. Solving it will require global cooperation, intensive research and innovation. Luckily, with the right attitude and sufficient effort solving this problem can strengthen the space industry and strengthen security at the same time. Private corporations and governments are already working together and new technologies enter the application phase at a quick pace. Refining SSA capabilities are already on the way, and we can already see the sprouts of a debris removal market. The coming decade will be decisive for space environment protection and therefore space activity.

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# Creativity in solving library problems and finding user-oriented solutions - analysis of examples from the world

Weronika Kortas, MA (Ph.D. Candidate)

Assistant in the Institute of Information and Communication Research, Faculty of Philosophy and Social Sciences,  
Nicolaus Copernicus University, Toruń, Poland  
wkortas@umk.pl

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## Abstract

More and more often, what the user wants or needs becomes the most important element in business, medicine, public administration, etc. This forces organizations and companies to adapt their offer and method of operation to the client. The service provider must convince the customer that by using his services or products, he will get real benefits. Therefore, methods and approaches that will allow service providers to look at the world through the eyes of customers and best match their offer to them are needed. Design thinking is such a method. It is a process related to cognitive, strategic, and practical activities in which a design concept (proposition of new products, services, etc.) is developed by designers and/or design teams. Design Thinking derives from the Human-Centered Design trend. The purpose of this method is to solve problems, create new, innovative products, services, or processes by determining the real needs of a single user. The keyword in this approach is 'creativity'. The article will cover the application of the creative problem-solving method and designing new solutions on the examples of libraries from different countries.

*Keywords:* library, creative problem solving, design thinking, case study, Human-Centered Design

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For many communities around the world, public libraries are the places where people - no matter what their education or skill level - have free access to information. It seems that although libraries have a lot of potential, this potential is not used. Many libraries have limited budgets and resources. The challenges faced by librarians are real, complex, and varied. Given the rapidly evolving way of transmitting information, librarians need new answers that require new perspectives, tools, and approaches.<sup>1</sup>

IDEO has produced a manual that describes a method that can help empower a library by better understanding the needs of users. This is possible thanks to the design thinking method. There are several sectors, such as business or education, where for years some institutions have used a people-centered approach to solve problems.<sup>2</sup>

The mentioned IDEO company is a global consulting company dealing with the design of innovative solutions for various enterprises: from start-ups and non-governmental organizations to international corporations.<sup>3</sup>

The values that form the basis of design thinking, i.e. empathy, teamwork, the linearity of teams, are nothing new. At the beginning of the 20th century, the Bauhaus university prioritized usability and the user above technical requirements or aesthetics.

The term "design thinking" appeared in the 1969 publication "The Science of the Artificial". Its author was Herbert Simon. The author was a supporter of creating prototypes and testing them on potential users. He believed that by making and fixing mistakes during test sessions, more valuable products can be created.

Another important author who emphasized the importance of design expertise in solving social and environmental problems is Victor Papanek. He is the author of the book "Design for the Real World", which was published in 1972.

Stanford professor David M. Kelly is also one of the people who contributed to the popularization of this method. Kelly is a co-founder of the IDEO design office. He believed that the world of design needed a change in the approach to creating projects. He emphasized that you should focus on the real needs of potential users, read their opinions, test projects, etc. IDEO started to use design thinking in its activities.<sup>4</sup>

Design thinking is both an approach and a way of looking at the world and it's human or user-centered. Design thinking is a creative approach that will help design appropriate solutions to various problems. As explained in *The Design Thinking for Libraries toolkit*, when we think about it as a Venn diagram, we will notice that design thinking solutions exist at the intersection of three factors: desirability, feasibility, and viability. In other words, when a solution is needed, it is financially feasible and technically possible - to implement it, then innovation is born [figure 1].

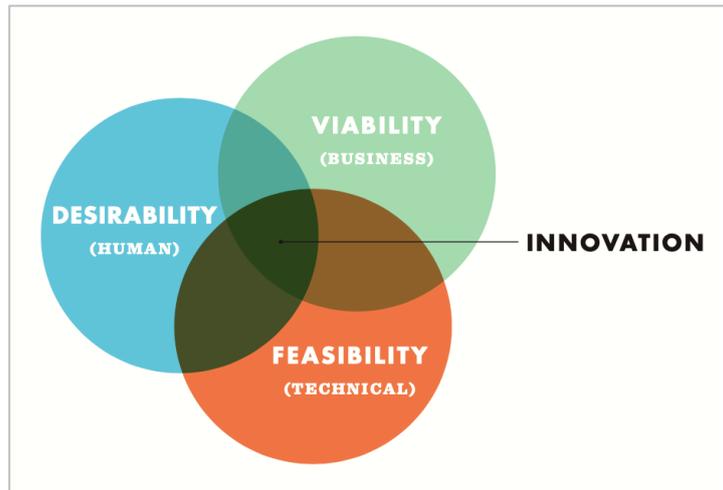
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<sup>1</sup> Design Thinking for Libraries toolkit, designthinkingforlibraries.com, p. 4 [17.01.2020].

<sup>2</sup> Ibidem.

<sup>3</sup> Ideo.com [17.01.2020].

<sup>4</sup> Michalska-Dominiak and Grocholiński, (2019), Poradnik design thinking – czyli jak wykorzystywać myślenie projektowe w biznesie, p. 17.



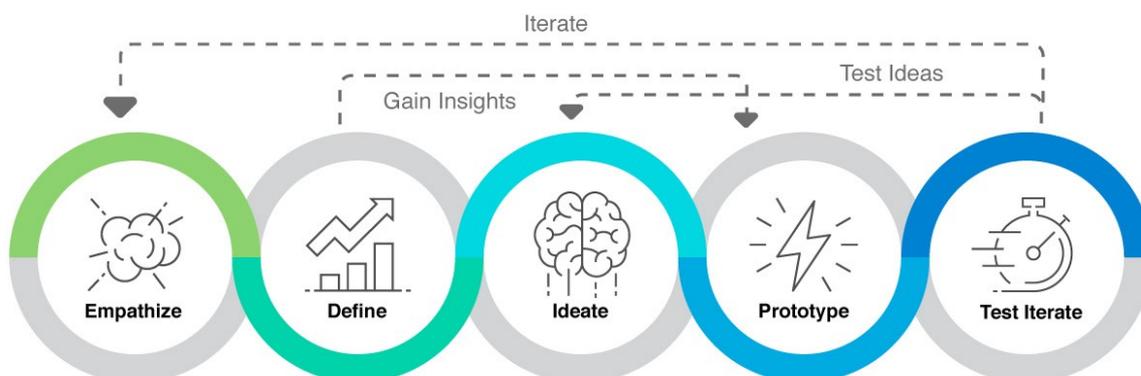
**Figure 11. Venn diagram of Innovation, Source: Design Thinking for Libraries toolkit, designthinkingforlibraries.com, p. 6 [17.01.2020].**

Design Thinking Process might seem linear and with an end but it's not, it is an iterative process. That is, it is the process of calculating the desired result using a repeated cycle of operations. The iterative process should converge, i.e. it should get closer to the desired result as the number of iterations increases.<sup>5</sup>

Overall, it can be said that design thinking consists of five successive steps. However, this is not entirely true. There is no rule that during the design process, you cannot move in both directions - forward and backward, or jump between steps. As already mentioned, design thinking is not a linear process.

#### The Five steps of Design Thinking [figure 2]:

1. Empathize—Research Your Users' Needs.
2. Define—State Your Users' Needs and Problems.
3. Ideate—Challenge Assumptions and Create Ideas.
4. Prototype—Start to Create Solutions.
5. Test—Try Your Solutions Out.



**Figure 12. Design Thinking Process Steps, source: <https://medium.com/designerrs/design-thinking-vs-ucd-811813e36052> [17.01.2020].**

<sup>5</sup> Web Dictionary of Cybernetics and Systems, [http://cleamc11.vub.ac.be/ASC/ITERAT\\_PROCE.html](http://cleamc11.vub.ac.be/ASC/ITERAT_PROCE.html) [17.01.2020].

As an encouragement to consider using this problem-solving method, some examples from around the world will be described. These examples are taken from the [designthinkingforlibraries.com](http://designthinkingforlibraries.com) website and the *Design Thinking for Libraries toolkit*. For more examples and more detailed descriptions, please refer to these sources.

### 1. How might play be integrated into Chicago Public Library core children's services?

Four children's librarians and a branch manager formed a project team at the Chicago Public Library. Inspired by their shared belief that play is integral to a child's development, they asked themselves: How can we integrate games in the Chicago library with basic children's services?

The work started with thorough research. From the interviews, the team learned about the different attitudes to play in the library, the type of support, and the challenges they can expect when creating a project. Drawing on inspiration from the research, the team started generating ideas. During the meetings, the designers talked about their experiences and formulated a few views that were to guide their design.

There are 4 main discoveries made by the team:

- Libraries are seen as the third safest place after school and home, and therefore offer potentially more opportunities to experiment with ideas.
- The library should be part of the research process in a child's life.
- Parents and librarians tend to control and structure play, so new programs should balance the need to control with the need to be flexible, which is an integral part of the play.
- Parents of school-aged children want a separation between play and study.

The team brainstormed the gathered information and started planning prototypes. Within a few hours, the team used simple and accessible materials like toys, etc. to create a new space for children to exchange stories. The prototype contained several elements for storytelling, such as a performance space, simple costumes, and hand-made puppets. Through play, children could use props and drawing tools to learn to create stories with a narrative. In total, several prototypes were created as a result of earlier user tests. One of the examples is the storytelling window.

While experimenting in different contexts, the team continued to learn about how each idea could be adapted to different staff backgrounds and cultures. The results were used as a basis for the design of several new spaces for children that promote play as the main theme of the site.<sup>6</sup>

### 2. A Branch Library Builds Trust with Local Teens

"Teens never come to the library" is a classic problem in the library world. At the Aaba Library in Aarhus, Denmark, a group of employees and volunteers, using a participatory budget allocated to the project, attempted to attract young people to the library. Their initial assumptions were quite predictable: "Today's youth find the library boring"; "Teenagers are too hyperactive to find a library attractive"; "Our actions aren't fun enough." Following the principle of design thinking, research was undertaken first to find out what the local youth is like. It was decided to hold many workshops in schools and afternoon activity clubs where they talked to teens about what libraries meant to them and to society and what could make libraries meaningful in their lives.

Librarians admitted that they learned many things about teenagers that they had no idea about, but the most important information they received in the context of their project was that they didn't feel welcome or comfortable in the library.

The library staff began to wonder how they can involve local youth in transforming the library into a place where they feel good? They decided to start with the "How might we" questions. These "are short questions that launch brainstorms".<sup>7</sup> Once they identified the main problem, they did more workshops and a collective brainstorm through digital installations in the schoolyards: this gave them more than 100 ideas to work with that they conceptualized and prioritized with the teens. After the selection of 10 items, a vote was ordered. Young people chose "the Chocolate Corner". A designated small part of the library was transformed into a place with comfortable furniture, board games, PlayStation, electric kettle, mugs, etc. The teenagers helped with the decoration and selection of furniture. They wanted this place to meet their needs.

After that, the library, and especially this space, is flooded with teenagers - especially on Chocolate Tuesdays and Thursdays. And there is a clear spillover effect for the rest of the week, and many other citizens use the Chocolate Corner for mother groups, study students, and family relaxation.<sup>8</sup>

### 3. Journey Mapping in Brazilian Libraries

Caravan Studios works alongside Brazilian NGO Recode in a program called Conecta Biblioteca that spans 26 Brazilian states plus the Federal District (Brasília). In their work with Conecta Biblioteca, Caravan Studios found Journey Mapping as a particularly useful method to deal with library problems. Journey Mapping is a design thinking tool that is widely used to understand and empathize with users. By using this method, barriers and levers along the customer's end-to-end path can be identified and used to redesign or rethink the entire customer experience. It is a very useful tool for creating human-centric designs.

<sup>6</sup> Design Thinking for... op.cit., pp. 11-14 [17.01.2020].

<sup>7</sup> Method: "How Might We" Questions, [http://crowdresearch.stanford.edu/w/img\\_auth.php/f/ff/How\\_might\\_we.pdf](http://crowdresearch.stanford.edu/w/img_auth.php/f/ff/How_might_we.pdf) [17.01.2020].

<sup>8</sup> A Branch Library Builds Trust with Local Teens, [designthinkingforlibraries.com/teens](http://designthinkingforlibraries.com/teens) [17.01.2020].

The designing process started with the research. They learned from the analysis of the collected information that libraries tend to be used by students who are studying for exams, or senior citizens reading the daily newspaper.

“Using Design Thinking and other community-based design and research methods was a way to bring librarians out from behind the counter, and to better understand community needs. They developed a landscape analysis tool called “Pesquisa da Comunidade,” or “Community Research,” (inspired by a method used by Caravan) to survey the community and consider the existing community assets. Through this process, they were able to better understand why people weren’t using the library and to figure out their wants and needs. The librarians thought about where the gaps were and explored what the community wanted.

After the community research, they used the Journey Mapping exercise (...) Journey Mapping was important for two reasons. First, a central goal of the Conecta Biblioteca project is to help library staff identify existing community assets and resources, and create new partnerships for the benefit of existing and potential users. As a high-quality, free, and widely available resource that any library worldwide can access, the Journey Mapping exercise answered these criteria. (...)

Second, Journey Mapping was a way to ground the team’s thinking and move from idea-generation into an active design phase.”<sup>9</sup>

## Conclusion

As the supporters of this method emphasize, design thinking can be used to deal with any challenge, such as programs, space, services, and systems. Examples of problems to be solved, written in the form of "How Might We" questions include, for example:

- How Might We... support and diversify early childhood reading and writing programs involving the whole family?
- How Might We... provide adequate help to adults learning IT, especially those adults who are reluctant to ask for help?
- How Might We... use unused space or reallocate space so that users can discover more of what the library has to offer?”<sup>10</sup>

Different methods can be used at different stages of design thinking. There is a lot to choose from. It is worth knowing and using methods appropriate to a given problem.

## Further Reading:

*Design Thinking for Libraries toolkit*, <http://designthinkingforlibraries.com/>

*Design Thinking for Libraries tools*, <http://designthinkingforlibraries.com/tools>

*Design Thinking for Libraries examples*, <http://designthinkingforlibraries.com/examples>

*Design Kit: Methods*, <https://www.designkit.org/methods>

## Literature:

*A Branch Library Builds Trust with Local Teens*, [designthinkingforlibraries.com/teens](http://designthinkingforlibraries.com/teens) [17.01.2020].

*Design Thinking for Libraries toolkit*, [designthinkingforlibraries.com](http://designthinkingforlibraries.com) [17.01.2020].

Designers Team, *Design Thinking vs. UCD*, <https://medium.com/designerrs/design-thinking-vs-ucd-811813e36052> [17.01.2020].

*Journey Mapping in Brazilian Libraries*, [designthinkingforlibraries.com/journey-mapping](http://designthinkingforlibraries.com/journey-mapping) [17.01.2020].

*Method: “How Might We” Questions*, [http://crowdresearch.stanford.edu/w/img\\_auth.php/f/ff/How\\_might\\_we.pdf](http://crowdresearch.stanford.edu/w/img_auth.php/f/ff/How_might_we.pdf) [17.01.2020].

Michalska-Dominiak and Grocholiński, (2019), *Poradnik design thinking – czyli jak wykorzystywać myślenie projektowe w biznesie*.

*Web Dictionary of Cybernetics and Systems*, [http://cleame11.vub.ac.be/ASC/ITERAT\\_PROCE.html](http://cleame11.vub.ac.be/ASC/ITERAT_PROCE.html)

<sup>9</sup> Journey Mapping in Brazilian Libraries, [designthinkingforlibraries.com/journey-mapping](http://designthinkingforlibraries.com/journey-mapping) [17.01.2020].

<sup>10</sup> Design Thinking for... op.cit., p. 17 [17.01.2020].

# **The contemporary role of libraries as hubs of innovation, creativity and knowledge in the service of local communities. The example of the Future Library Network**

**Dr. Eleni Alexandri<sup>1\*</sup>, Dr. Antonia Tzanavara<sup>2\*</sup>,**

*<sup>1</sup>Assistant Professor at the University of West Attica ([alexandrieleni2@gmail.com](mailto:alexandrieleni2@gmail.com))*

*<sup>2</sup>Adjunct Lecturer, Hellenic Open University ([tzanavara.antonina@ac.eap.gr](mailto:tzanavara.antonina@ac.eap.gr))*

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## **Abstract**

Libraries are acknowledged for their traditional role in collecting and archiving documented heritage, preserving cultural and historical memory and promoting knowledge. However, international experience has shown that conventional practices are no longer sufficient; the library of the 21st century should take in a new role as cultural institution. This new type of libraries though, should not be viewed as an alternative to the "traditional" ones, but a complement that will add to the concept of "Library" new dimensions and possibilities. The paper examines the contemporary role of libraries as hubs of innovation,

creativity and knowledge in the service of local communities. Contemporary libraries redefine the mission of the “traditional” library, enhance its activities and services with the ability to integrate into the community and undertake an active role within the educational, cultural and social status. Not only do they meet the needs for knowledge of its users and provide them with useful information in their daily lives, but also create for them an interactive cultural and educational environment.

It draws mainly, on the transformation of libraries from neutral and often indifferent public spaces to unconventional cultural spaces, which encourages innovation and creativity, while supports human communication and exchange of ideas and social cohesion promotion.

The paper presents as case study the Future Library (Greece), a non-profit organization which contributed to the development of a sustainable network of public & municipal libraries across the country and reinforced the significance of libraries as “knowledge, creativity and interaction-promoting institutions”, positively affecting the life of local communities.

*Keywords:* Library, contemporary role, cultural space, innovation, creativity, knowledge, community

## Introduction

*"Bad libraries build collections,  
good libraries build services,  
great libraries build communities."  
R. David Lankes*

At the beginning of the 19th C., the first libraries accessible to the general public are created in Greece, as a result of a general trend in Europe at that time, promoting the idea of a library open to anyone who would be interested in using its services. Libraries were established either by the state or, in most cases, as a result of a private initiative by inspired people who loved knowledge and recognized its importance for the spiritual development of the people.<sup>1</sup>

Libraries and culture have therefore been interconnected and interdependent concepts over the centuries. Libraries became important custodians of human knowledge and the springboard for man to progress in every area of his life, as they passed on knowledge and experiences of the past, which proved to be useful in human activity in general.

According to John Cotton Dana (1856-1929)<sup>2</sup>, a man with the vision of the democratization of Museums and Libraries and a pioneer in the organization and operation of modern libraries, *"a public library should function primarily as a place of entertainment and education for the public"* and not as a conservative institution, inaccessible to the masses, addressed mainly or exclusively to an elite of intellectuals and wealthy bourgeois. Dana promotes a type of library that allows users, including children, free access to its collections, a library that creates a welcoming environment for them (Hanson, 1991: 259), as an appealing learning space for all, an active institution that anticipates and meets the needs of the local community in the acquisition of knowledge. (Dana, 1895: 12-15) Dana (1903) fought for a library that protects intellectual heritage, that preserves the historical and collective memory of people, that supports the right to knowledge.

Dana's ideas remained utopian until a few decades ago when the orientation of libraries started to shift internationally. Libraries gradually began to be transformed from *"obsolete book depositories for a selected audience, into vital spaces of culture, information and education for all"* (Kyriaki - Manesi, 2006).

Many people still hold the archaic view of libraries but more and more realize their prominent role as conduits of culture, learning and social connection. Thus, a new identity is acknowledged, the one of a place of cultural reference in a local community, a vital place that could and should empower and influence people, a place where they could meet, socialize, get inspired, exchange knowledge, a place for civic dialogue and access to information and eventually a hub of innovation and creativity, that reduces social isolation and promotes social cohesion.

### **From the “Traditional Institution” to the “Cultural Community Hub”: The new type of Libraries**

The organization, preservation, bookbinding and maintenance of its collections, the acquisition of material, its descriptive and thematic indexing, the classification, classification and cataloging of items are basic functions of a traditional library that should be served regardless of audience and circumstances (Gerolimos, 2008), functions that should not be underestimated.

However, international experience has shown that conventional functions are no longer sufficient; the library of the 21st century can only be sustainable if, on the one hand, it realizes the modern reality created by the Information and Knowledge Society and, on the other hand, accepts its new role as cultural institution. The library must not only meet the knowledge needs of its users and provide them with the conditions to access information, but also to educate and entertain them in a qualitative way, constituting an appealing, vital, cultural environment.

The increasing use of New Technologies in the learning process, mostly by children and young people, has also led modern libraries to adopt new principles and apply innovative methods and tools to serve the reading public. As Social Networking and the Web have become an integral part of the social and cultural everyday life of users, the new type of a library is seeking an

<sup>1</sup> [http://www.emne-mnimon.gr/greek/psifopoiimeno\\_iliko-l-6.html](http://www.emne-mnimon.gr/greek/psifopoiimeno_iliko-l-6.html) (access 18/12/2020)

<sup>2</sup> American Museum Superintendent and Librarian Theorist for more than forty years in the late 19th and early 20th centuries

active role as a hub center of information, learning, creativity, interaction and social cohesion, involving the public in participatory activities, where community members are sensitized, communicate, "discover", express, learn, interact. According to Watson (2011), digital media have changed attitudes, behaviors and relationships. This can also happen within a library, when realizing its power and the influence it can have on the local community, as long as it is open to the prospect of its evolution into a cultural hub in local communities, a place where people can gather, converse, get inspired, exchange knowledge, ideas and experiences, a place where they cannot only "borrow books", but also a place where "local people and ideas come together". Libraries as hubs of innovation, creativity and knowledge in the service of local communities are places, where "people exchange knowledge, wisdom, insight and, most importantly of all, human dignity". They are not just about "borrowing books or storing physical artefacts". They are about being pillars of social integration, cohesion and engagement for all. They are places of local gathering, vibrant hubs where "individuals come to sit quietly and think, free from the distractions of our digital age". They are and they should be about people, not about things, more about their users, than exclusively or mainly about books.<sup>3</sup> They can and they should be cultural community hubs, quality places that focus on activities, services and facilities, open to a wide range of community groups, hubs that have "an important social function bringing people together..., addressing isolation... a safe space where everyone can feel welcome and comfortable".<sup>4</sup> As Rankin and Brock (2012) refer to their book "Library Services for Children and Young People: Challenges and opportunities in the digital age", people grow up in a social and cultural environment, where they receive a variety of influences and prospects. Public and municipal libraries can play a valuable role in this environment by providing both vital aid to their literacy development and special services for children and youth, by supporting, inspiring and enhancing their imagination and creativity, as well as expanding other existing skills.

### The Future Library Network

*A smart library,  
an open approach*  
Future Library

One of the most debated topics in the last years, is no doubt how libraries could survive in an increasingly digital world, resulting to their undervaluation and underestimation as cultural institutions. As technology became more and more prevalent in daily lives, libraries had to undertake an active role as key elements for open access to formal and informal learning, which is crucial to democratic information society development.

The difficulty of Greek libraries to communicate that they don't exist just for lending books, their inability for self-promotion as "centers of communities" that foster life-long learning, creativity and entertainment, their incompetence for extroversion and attraction of new audiences, beyond those who usually, due to their status or occupation choose to use traditional library services, were considered by the Future Library network.

The Future Library, a non-profit organization founded by the Public Central Library of Veria, was established in 2011, addressing the call of the Stavros Niarchos Foundation to contribute to the development of a sustainable network of public & municipal libraries across Greece, with the aim of "reinforcing the significance of libraries and transforming them into unique centers of creativity, interaction, innovation and learning".<sup>5</sup> In 2016, the baton of this social network was passed to the National Library of Greece that committed to sustain the program in its new premises, at the Stavros Niarchos Foundation Cultural Center. Throughout its journey the robust network has embraced 167 libraries and harnessed hundreds of librarians, library leaders and stakeholders. It has paved new ways and created new choices for sustainability, empowering and affecting positively life in local communities, by engaging them to co-develop new library spaces and services, accessible to all citizens, such as children libraries, media labs for youth, programs and campaigns to promote reading, creativity collaboration, socialization.<sup>6</sup>

Day by day, more and more people of various ages and backgrounds, from pre-school toddlers with their parents, teenagers and university students, to freelancers, professionals, volunteers and senior citizens connected to their hometown libraries, by participating to various programs and activities, involving the use of new technologies.

As Mr. Trochopoulos, director of the Veria Central Public Library and winner of the 2010 Access to Learning Award of Bill and Melinda Gates Foundation, states "culture is not only the responsibility of the State, it should be mainly, the responsibility of all citizens".<sup>7</sup> Consequently, the contemporary library as a cultural institution should be placed in the heart of local communities as a new source of cultural interest and operate through fruitful synergies with local cultural institutions, through creative activities for users of all ages.

### The Future Library "Summer Campaign"

*"What can a child do in a library?" and  
"What can a library offer to a child?"*  
Future Library

<sup>3</sup> Watson, R., PUBLIC LIBRARIES: IF WE DIDN'T HAVE THEM ALREADY, WE WOULD HAVE TO INVENT THEM, <http://www.austlii.edu.au/au/journals/inCiteALIA/2011/316.pdf>

<sup>4</sup> Thomson, L. & Murray-Sanderson A. (2017), Libraries as community hubs: Case studies and learning. A report for Arts Council England, <https://www.artscouncil.org.uk/sites/default/files/download-file/Libraries-CommunityHubs-Renaisi.pdf>

<sup>5</sup> Future Library SNAPSHOTS OF OUR WORK (2016), [https://en.unesco.org/creativity/sites/creativity/files/periodic\\_reports/files/annex\\_7\\_-\\_future\\_library\\_work-compressed.pdf](https://en.unesco.org/creativity/sites/creativity/files/periodic_reports/files/annex_7_-_future_library_work-compressed.pdf)

<sup>6</sup> <https://www.futurelibrary.gr/index.html>

<sup>7</sup> Future Library- Οι βιβλιοθήκες εκπαιδεύονται, <http://parallaximag.gr/reportage/future-library-oi-vivliothikes-ekpaidevontai>

In the direction of reviving libraries, redefining and revalidating their role by adding a social and cultural value, the FUTURE LIBRARY network proposed the organization of a "Summer Campaign", for the promotion of readership and creativity, making participating libraries the center of their communities for three months, transforming them to places of creative activity, places of interaction and exchange of ideas.

Given the fact that summer season is suitable for cultural events and educational activities, which could either be addressed exclusively and occasionally separately to young or older people, or could be offered for fruitful interaction of different generations, in a hive of creativity, carried out with the initiative and coordination of the Future Library and with the exclusive donor of the Stavros Niarchos Foundation<sup>8</sup>, the network suggested for the first time during the summer of 2012 the organization of a Summer Campaign, concurrently in all libraries involved at that time.<sup>9</sup> The employees of the Public and Municipal Libraries exchanged knowledge and ideas about designing alternative activities that promoted new means of expression and experimentation, new forms of entertainment and approaching knowledge using innovative tools, not to be expected by the "conventional" type of library of the past. The campaign re-introduced the local libraries to the public by providing them innovative and creative ways for "edutainment" (education and entertainment) (fig. 1-3)



Fig. 1 Summer Campaign posters (2013-2016)

<http://libkor.gr/vivliothiki/>

The 1st Summer Campaign, entitled "Compass Routes to the Library" took place in 72 libraries of the network and included 1,450 events, where participants had the opportunity to play, watch theatrical and visual activities centered on books, experiment to photograph and to make short films.<sup>10</sup> During the (2d)?? Summer Campaign the number of participating libraries turned to 103, while 3.472 events were performed. The third year during the campaign titled "Whatever you think, think the opposite"<sup>11</sup> 140 libraries presented 3480 events and workshops for children in their communities. As noted by the director of the Future Library, Mr Dimitris Protopsaltou "Of all the Future Library activities, the Summer Campaign has the greatest impact,

<sup>8</sup> 3η Καλοκαιρινή Εκστρατεία Future Library (3d Summer Campaign Future Library) (2014), <https://www.elculture.gr/blog/announcements/future-library-kalokairini-ekstrateia/>

<sup>9</sup> Libraries of the future (2015), <https://www.snf.org/en/newsroom/news/2015/10/libraries-of-the-future/>

<sup>10</sup> Protopsaltou, D. (2012), Access to all, Opportunities for All, [helios-eie.ekt.gr](http://helios-eie.ekt.gr)

<sup>11</sup> The Future Library, <https://athenscentre.gr/the-future-library/>

*geographically and demographically.*" Correspondingly, the fact that the number of children participating has remarkably increased since the 1<sup>st</sup> Summer Campaign, allows us to assume that “*libraries can offer something qualitative something that lasts*”. The sociologist Irini Vokotopoulou, responsible for designing educational programs and actions on behalf of the Future Library, presents the purpose of summer campaigns which is primarily “*to build a way of operating children's libraries, to educate children, parents and library staff that reading does not mean reading and presenting a book, but approaching a topic from many perspectives...*” and development of the children's combinatorial and critical ability “*.<sup>12</sup>* By designing intergenerational programs, the aim of Future Library Summer Campaign is to introduce different community groups to the concept of reading through participating into innovative activities.



Fig. 2 4<sup>th</sup> Summer Campaign (Municipal Library of Korinthos, Greece)  
<http://libkor.gr/vivliothiki/ekdiloseis/2015?start=30>



Fig. 3 4<sup>th</sup> Summer Campaign (Municipal Library of Korinthos, Greece)  
<http://libkor.gr/vivliothiki/ekdiloseis/2015?start=30>

### Conclusion

In the 21st century, there is an increasing trend towards “*revamping libraries as part of a wider community resource*” and a growing interest in the social impact of them as agents for social change, in order to create a “*community ‘campus’ that goes beyond the traditional book-based library service*”<sup>13</sup>, beyond the idea of libraries mission as repository of books. The evidence

<sup>12</sup> Future Library: Καλοκαιρινή Εκστρατεία 2014, <https://www.tovima.gr/2014/06/26/culture/future-library-kalokairini-ekstrateia-2014/>

<sup>13</sup> Libraries as community hubs, <http://designinglibraries.org.uk/index.asp?PageID=414>

shows that libraries redefine their cultural, social and educational mission and alongside to their traditional functions, they identify the needs of the local community, they introduce new services and recreational programs for all audiences, they reach out to the local community, beyond the library walls and they undertake an evolving, essential and valuable role to play in the community development.

They cultivate a welcoming and supportive environment, they facilitate community engagement, by designing and effectively delivering a variety of engaging programs and activities. They communicate and collaborate in partnership with other organizations, they stay informed of trends in emerging technologies, the digital world, the social media and their implications for children and youth. Libraries in the 21<sup>st</sup> century constitute cultural and social hubs, which encourage relaxation, imagination, personal expression, entertainment and creativity.

The example of the Future Library network, justifies that contemporary libraries facilitate the right of people to information, providing open access to all resources and media, reinforce cultural development to local users, encourage lifelong learning, empower creativity and enhance innovation.

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# The Determinants of Firm Investments in Research and Development

Alberto Costantiello<sup>1</sup>, Lucio Laureti<sup>2</sup>, Angelo Legrande PhD<sup>3</sup>

<sup>1</sup>Professor of Economics and International Economics, LUM University, Italy

<sup>2</sup>Professor of Economics, LUM University, Italy

<sup>3</sup>Scholar in the Discipline of Economics, LUM University, Italy

\*Corresponding author email: [costantiello@lum.it](mailto:costantiello@lum.it)

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## Abstract

In this article we investigate the political and industrial determinants of firm investment in Research and Development. We use data from the European Innovation Scoreboard of the European Commission for 36 countries in the period 2000-2019. We found that firm investments in Research and Development are positively associated with “Linkages”, “Innovation Index”, “International Co-publications”, “Medium and high-tech product exports”, “Non-R&D innovation expenditure”, “Turnover share large enterprises”, “Human Resources”, “Intellectual Assets”. Firm investments in Research and Development are negatively associated to “Foreign doctorate students”, “Knowledge-intensive services exports”, “Private co-funding of public R&D expenditures”, “Basic-school entrepreneurial education and training (SD)”, “New doctorate graduates”, “Trademark applications”, “Tertiary education” “Design applications”, “Lifelong Learning”, “Foreign-controlled enterprises – share of value added (SD)”, “Total Entrepreneurial Activity (TEA) (SD)”.

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## 1. Introduction

The role of innovation has been recognized as an essential tool for economic growth. The Solow growth model (Solow, 1956) considers the human capital as a determinant to improve the degree of technology and improve the degree of efficiency of labor. The endogenous growth theory (Romer, 1994) puts the technology at the center of the economic process considering the technological change as the main force that can improve outputs in the short term with fixed or quasi-fixed inputs. Schumpeterian economics (Schumpeter, 2013) has introduced the idea of the innovation for the process of economic growth either in the complex dynamics of the creative-destruction. In this article we try to understand what the determinants of the corporate investment in innovation in Europe are. We consider data from the European Innovation Scoreboard in the period 2000-2019 for 39 countries<sup>1</sup>. We perform panel data econometrics with fixed effects, random effects, pooled OLS, WLS and dynamic panel at 1 stage. We found that the probability of a corporation to invest in innovation in Europe is positively associated to: “*Intellectual assets*”, “*Human resources*”, “*Non-R&D innovation expenditures*”, “*Medium and high tech product exports*”, “*International co-publications*”, “*Innovation index*”, “*Linkages*”. The probability of European corporations to invest in innovation in Europe is negatively associated to “*Foreign doctorate students*”, “*Knowledge-intensive services exports*”, “*Private co-funding of public R&D expenditures*”, “*Basic-school entrepreneurial education and training (SD)*”; “*New doctorate graduates*”, “*Trademark applications*”, “*Tertiary education*”, “*Design applications*”, “*Lifelong learning*”, “*Foreign-controlled enterprises – share of value added (SD)*”, “*Total Entrepreneurial Activity (TEA)*”. The article continues as follows: the second paragraph considers a short analysis of the literature with a focus on R&D intensity; the third paragraph presents the econometric model and the synthesis of the main results, the fourth paragraph contains the conclusions, the fifth paragraph indicates the bibliographical references, the sixth paragraphs is the appendix with the econometric analysis.

## 2. Literature review

Research and Development intensity can be calculated in two methods: directly and indirectly. Direct R&D intensity is defined R&D expenditure divided by output  $R\&D\text{Intensity} = \frac{R\&D\text{Intensity}}{\text{Output}}$ . Indirect R&D intensity is the value of knowledge in

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<sup>1</sup> Countries are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finlandia, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, UK.

intermediate goods and services. There is an essential difference between direct R&D intensity and indirect R&D intensity i.e. that while on one side direct R&D intensity can be analyzed using balance sheet data at a firm level on the other side indirect R&D intensity can be calculated with input-output tables

(Ugur, et al., 2016) afford the question of the relationship between R&D intensity and firm survival. The authors analyze 37.930 R&D active firms in the UK in the period 1998-2012. The results are as follows:

- The relationship between Research and Development intensity and firm survival as an inverted U shape pattern;
- Research and Development intensity grows with the degree of concentration of a market;
- Creative destruction has a negative effect on R&D intensity.

The authors control the results for age, size, and productivity.

(Padgett & Galan, 2010) analyze the impact of Research and Development intensity on Corporate Social Responsibility. The authors focalize on the intangible resources. There is a positive association between Corporate Social Responsibility and Research and Development activity since both created intangible values and empower either stakeholders either communities. The authors analyze either manufacturing industries either non-manufacturing industries and find that Research and Development intensity positively affect Corporate Social Responsibility in manufacturing industries. The positive relationship between Research and Development and Corporate Social Responsibility is absent for the case of non-manufacturing industries.

(Churchill, et al., 2019) question the relationship between Research and Development intensity and CO2 emission per capita in G7 countries. The authors find that R&D activities have a positive effect on reducing CO2 emissions in G7 countries. Results shows that 1% increase in R&D intensity reduces CO2 emissions between 0.13% and 0.16%.

(Falk, 2012) affords the question of the relationship between Research and Development intensity and firm growth activities in Austria in the period 1995-2006. The results show that R&D intensity has a positive effect on employment and sales growth. But the impact of R&D on firm growth decreases over time.

(Mathieu & De La Potterie, 2010) analyze how macro-economic conditions on a country level base can impact aggregate R&D intensity. The authors analyze 21 industrial sectors, 18 countries in 5 years. Results show that there is a positive relationship between national industrial structure and R&D intensity on a country base. The authors find that there are countries in which the macroeconomic environment is particularly favorable to R&D and countries in which the R&D intensity is based on R&D expected returns such as in USA, Sweden, and Japan.

(Savrul & Incekara, 2015) afford the question of the increasing relevance of knowledge and technology in the globalization as instruments to promote economic growth. There are two methodologies by which countries can improve the investment in knowledge and technology: on one hand countries can implement specific policies that improve the degree of technical knowledge or on the other hand firms can spontaneously create and promote a cultural and productive environment oriented to innovation and Research and Development. But if countries need to improve the level of innovation than they should focus on appropriate policies and investments either public either private. But not all investments in innovation can improve innovation performance. The authors conclude that environmental and cultural factors have a relevant role in reducing the gap between innovation investments and innovation performance.

(Gentry & Shen, 2013) afford the question of the relationship between risk averse managers and Research and Development expenditures in firms that are influenced by external evaluations such as that of forecasting analysts. The authors find that managers are oriented to cut R&D expenditures during a crisis or either in the case of missing target. Authors use data from US manufacturing firms during the period 1979-2005.

(Adomako, et al., 2019) analyze the relationship between Research and Development and New Product Performance-NPP. The authors report literature that explains the presence of a positive relationship between Research and Development and New Product Performance. But to better understand the question authors introduce the idea of international R&D i.e., the fact that R&D cannot produce autonomously by single countries, but it is at the contrary based on the presence of international R&D teams. The authors analyze 201 Ghanaian firms and find that there is a positive relationship between R&D and New Product Performance especially for that firms that relate to international R&D team.

(Nunes, et al., 2012) afford the impact of R&D intensity either in high tech either in non-high tech small sized enterprise. The results show that R&D intensity has a positive effect for firm growth only for high tech small enterprises. R&D intensity has no effect for low-tech small and medium enterprises. But the authors also find that younger and smaller non-high tech SMEs can benefit from R&D intensity at least better than older, larger non-high tech SMEs.

(Booltink & Saka-Helmhout, 2018) afford the question of the relationship between R&D investment and non-high tech small enterprises. The authors consider that while it is certain that while on one hand R&D intensity is positively associated to the performance of high-tech small enterprises on the other hand R&D intensity is negatively correlated to the performance firm in non-high tech small enterprises. The degree of R&D investment in non-high tech firms is limited. But the investment in R&D for non-high tech SMEs is also important for their performance and survival. The authors find an inverted U-shaped relationship between R&D intensity and non high-tech SMEs performance. Non high-tech SMEs that are oriented to exportations can benefit more from R&D investments.

(Wang, et al., 2018) analyze the relationship between political, managerial, and cognitive bias in respect to R&D. The authors believe that political influences and managerial cognitive biases can reduce the degree of R&D intensity in developing countries. 1.293 Chinese listed firms are analyzed in the period 2010-2014. The authors find the sequent results:

- If manager are subject to political ties than they can reduce the degree of R&D intensity;
- Managers overconfidence improve R&D intensity;
- If managers are either subjects to political ties and either overconfident than R&D intensity tends to growth;

The authors conclude that an appropriate managerial mind-set based on overconfidence can improve R&D investments in emerging countries.

(Diéguez-Soto, et al., 2019) analyze the relationship among Research and Development intensity, family management and firm performance. Family management is negatively associated to firm performance. Research and Development intensity is positively associated to firm performance. Research and Development intensity alleviate the negative impact of family management on firm performance.

(Purkayastha, et al., 2018) affords the question of the relationship between R&D intensity and the degree of internationalization. The authors show the presence of a positive relationship between R&D intensity and internationalization in Indian firms.

(Min & Smyth, 2016) analyze the relationship among Research and Development intensity, corporate leverage, and growth opportunities. The authors find that generally Research and Development is positively associated to growth opportunities. But for firms that have greater leverage the impact of Research and Development is negatively associated to growth. The authors use a dataset with data of South Korea.

(Yunlu & Murphy, 2012) afford the question of the ability of managers to invest in Research and Development during a recession. Empirical analysis shows that during a recession there is a reduction in R&D spending. But, controlling for the characteristics of the CEOs, the authors find that CEOs with shorter career horizon tend to reduce the investment in Research and Development more than CEOs with longer career horizon. The authors suggest that the individual incentives of CEOs in connection with their career expectation can have a role in the investment choice in Research and Development during a recession.

(Padgett & Moura-Leite, 2012) afford the question of the relationship between Research and Development intensity and corporate reputation. The authors tested their hypothesis on 257 US firms in the period 2004-2007. The authors try to analyze the relationship between Research and Development intensity and corporate reputation especially for that innovation that can produce social benefits that are valuable for stakeholders. If firms in boosting their expenditure in Research and Development can produce social valuable innovation than the corporate reputation of the firm increases. Managers can improve the corporate reputation of firms investing in Research and Development in connection with corporate social responsibility. The increasing in Corporate Reputation, Corporate Social Responsibility and Research and Development can offer greater probability to improve profits in the long run.

(Bordons, et al., 2015) afford the question of the positive relationship between international collaboration and Research and Development. The authors analyzed 9.961 scientific article. The results show that the large part of the bilateral collaboration have been realized among countries with high Research and Development intensity. The presence of a positive relationship between co-publication and countries with an elevated degree of Research and Development intensity is high especially in Social Sciences. Mathematics is the only field in which international collaboration among co-authors is relatively independent from Research and Development intensity at a country level.

(Naik, et al., 2014) afford the question of the relationship between R&D expenditure and market valuation of the firm. The authors use data from 326 R&D Indian firms in the period 2001-2010. Results shows the presence of an inverted U-shaped relationship between R&D intensity and firm value. The relationship between R&D investment and the firm value is rising until the optimal point. After the optimal point, the marginal investment in R&D has decreasing returns.

(Veugelers & Cincera, 2010) analyze the degree of innovation in the European Union. The authors find that the level of innovation in European Union is low especially controlling for the degree of Research and Development in the business sector. In a confrontation with USA the weakness of EU consists in the fact that new firms play a marginal role in the sense of innovation especially for high-tech industries. The authors find that effectively the level of innovative young firms in Europe is lower than the analogous in the US. But the main point of the authors is the fact that young leading innovators in Europe generate lower level of Research and Development in respect to their counterparts. The authors conclude that the R&D gap between EU and USA is not only due to the demography of young tech firms, but it is ascribable to deeper and structural investments.

(Kraiczy, et al., 2015) afford the question of the relationship between CEOs culture and the investment in Research and Development. The authors refer to the “*upper echelon theory*” i.e., a theory that consider the organizational outcomes as a function of managerial cultures and values. The expenditure in Research and Development can be predicted by the presence of managerial individual characteristics i.e., behaviors, values, personalities, motivations, and executives’ experiences. The authors consider the relationship among firm growth, Research and Development intensity and CEO orientation toward innovation. The study analyzes also if the CEO orientation toward Research and Development change in respect to dimension of the firm and in connection to the economic cycle. The study analyzes 77 German CEOs of SMEs. The result shows the presence of a positive effect between R&D intensity and CEO’s orientation toward innovation. The positive effect between CEO innovation orientation and R&D intensity is greater in firms with low growth.

### 3. The model

The sequent model is estimated:

$$\begin{aligned}
& \mathbf{FirmInvestment}_{it} \\
& = a_1 + b_1(\mathbf{BasicSchoolEntrepreneurialEducationAndTraining})_{it} \\
& + b_2(\mathbf{DesignApplications})_{it} + b_3(\mathbf{ForeignDoctoreStudents})_{it} \\
& + b_4(\mathbf{ForeignControlledEnterprisesShareOfValueAdded})_{it} + b_5(\mathbf{HumanResources})_{it} \\
& + b_6(\mathbf{InnovationIndex})_{it} + b_7(\mathbf{IntellectualAssets})_{it} + b_8(\mathbf{InternationalCoPublications})_{it} \\
& + b_9(\mathbf{KnowledgeIntensiveServicesExports})_{it} + b_{10}(\mathbf{LifelongLearning})_{it} + b_{11}(\mathbf{Linkages})_{it} \\
& + b_{12}(\mathbf{MediumAndHighTechProductExports})_{it} + b_{13}(\mathbf{NewDoctorateGraduates})_{it} \\
& + b_{14}(\mathbf{NonR\&DInnovationExpenditure})_{it} \\
& + b_{15}(\mathbf{PrivateCoFundingOfPublicR\&DExpenditures})_{it} + b_{16}(\mathbf{TertiaryEducation})_{it} \\
& + b_{17}(\mathbf{TotalEntrepreneurialActivity})_{it} + b_{18}(\mathbf{TrademarkApplication})_{it} \\
& + b_{19}(\mathbf{TurnoverShareLargeEnterprises})_{it}
\end{aligned}$$

With  $i = \text{countries}$ ,  $t = \text{time}$

The econometric analysis shows that the degree of firm investment in innovation is positively associated with:

- *Intellectual assets*: captures different forms of Intellectual Property Rights -IPR generated in the innovation process. This means that the probability of a firm to invest in innovation increases with the diffusion of property rights and patents. Corporations that operate in entrepreneurial environments characterized by the presence of patents can have more opportunities to improve the innovativeness of their business through investment.
- *Human resources*: is a global measure of the diffusion of scientific and technical knowledge among the workforce population. If a firm can employ workers with a high human capital than there are more probabilities to improve the investment in innovation. In effect a qualified human capital has more ability to create innovation either in R&D activities either in non-R&D operations.
- *Turnover share large enterprises*: this is a measure of a turnover in enterprises with more than 250 employees. There is a positive relationship between turnover in large enterprises and the corporate innovation investment in Europe. Turnover in effect can liberate qualified workforce that can be employed successively in other corporations improving the degree of innovation.
- *Non R&D innovation expenditures*: is the complex of innovation that can be realized either outside the R&D department. Non-R&D innovation expenditures give to firms a more innovative approach since all the departments and functions of the firm participate actively in the process of innovation. The net effect is a more innovative orientation of the corporation.
- *Medium and high-tech product exports*: corporations that operate in economic environment based on a deep orientation toward exportation of medium and high-tech products invest more in innovation. This deep orientation toward innovation can be explained since in the presence of exportations firms can improve their returns on investment associated to innovation.
- *International co-publications*: the presence of international relations among scholars oriented to improve publication can offer a cultural environment favorable to science and technology that can induce corporations to improve their investments.
- *Innovation index*: is a global measure of the orientation of a country toward innovation not only in the private sector but also in the public sector. If a firm is inserted in a environment positively shaped by a high degree of innovativeness then there are greater probabilities that that firm could improve their investment in innovation.
- *Linkages*: is a measure of the degree of interconnectedness among private sector, public sector and financial sector in the sense of innovation. The greater the interconnectedness among these sectors the greater the probability that a corporation improve the investment in innovation.

We found that the degree of firm investment in innovation is negatively associated to:

- *Foreign doctorate students*: is the share of foreign doctorate students that reflect international mobility. The share of foreign doctorate students can be considered as an essential variable to improve the degree of research in a country. But the improving share of foreign doctorate student misses the positive relationship with the corporate innovation investment. The negative relationship between foreign doctorate students and the corporate innovation investment can be explained considering that firms seems to be indifferent to the quality of tertiary education.
- *Knowledge-intensive services exports*: is a measure of the competitiveness of the knowledge intensive service sector. But, contrary to the export of high-tech products, the exportation of knowledge intensive services is negatively associated to corporate innovation investment. This can be since the service sector is more based on intangible assets and require less investment in equipment, machinery, infrastructures, and intermediate goods.
- *Private co-funding of public R&D expenditures*: is a measure of the cooperation between the public and the private sector to improve the degree of innovativeness of a productive system at a country level. But there is a negative trade off between the financial resources that a firm can use to boost the public-private partnership and the resources that firm can use to invest in the innovation process.
- *Basic-school entrepreneurial education and training*: is a measure of the ability of an educational system at a national level to promote business culture. There is a negative relationship between the corporate innovation investment and the educational level in business in the 36 countries of the analyzed dataset for the period 2000-2019.

- *New doctorate graduates*: is a measure of the supply in tertiary education. This variable is negatively associated to the corporate innovation investment in Europe. Even if the general level of human resources is positively associated to corporate innovation investment, the specific increase of the number of doctorate graduate do not improve the innovation investment among corporations.
- *Trademark applications*: is a relevant variable to boost the economics of the service sectors. Since trademark application can guarantee the origin of goods and services and it is a form of communication especially for publicity and advertising. But the choice of a corporation to invest in innovation does not depend on the improving of trademark applications. Corporations are more interested in patents and intellectual property rights that can be used to produce new products and services rather than in trademark applications.
- *Tertiary education*: this is a measure that consider the supply of advanced skills in the workforce population. But this variable comprehends either scientific either non-scientific skills. Specifically, non-scientific skills are more widespread in the service sector rather than in the manufacturing sector. Firms that invest in innovation are more oriented to product innovation than to process innovation and are more sensible to the presence of a specific workforce that has skills in STEM fields.
- *Design applications*: is the recognizing of rights that regard the lines, contours, colors, shape, texture, materials, and ornamentation of a product or of a part of a product. The increasing of design application is negatively associated to the decision of a corporation to invest in innovation in Europe. Design has in effect more affinity with marketing than with innovation.
- *Lifelong learning*: is the process of continuous learning either formal either informal of population at a country level. Lifelong learning activities does not comprehend cultural and sporting activities. Lifelong learning is negatively associated to the decision of a firm to invest in innovation. The negative relationship can be better understood considering that lifelong learning is not necessarily oriented to scientific and technological knowledge and consequently is not necessarily associated to the decision of a corporation to invest in innovation.
- *Foreign-controlled enterprises – share of value added*: the presence of foreign controlled enterprises is negatively associated to the probability of a corporation to invest in innovation. In effect generally foreign controlled enterprises operate in low and medium tech industries that require low or no investments in innovations. The diffusion of low or medium tech corporations depresses the degree of innovation among corporations.
- *Total Entrepreneurial Activity (TEA)*: is the percentage of the population that is an entrepreneur or a owner manager of a business. This variable is negatively associated to the probability of a corporation to invest in innovation. When a firm decides to invest in innovation is not interested in the percentage of entrepreneurs presents among the population but, at the contrary, it is more interested in the quality of innovation and in the orientation of the entire productive system towards high tech industries.

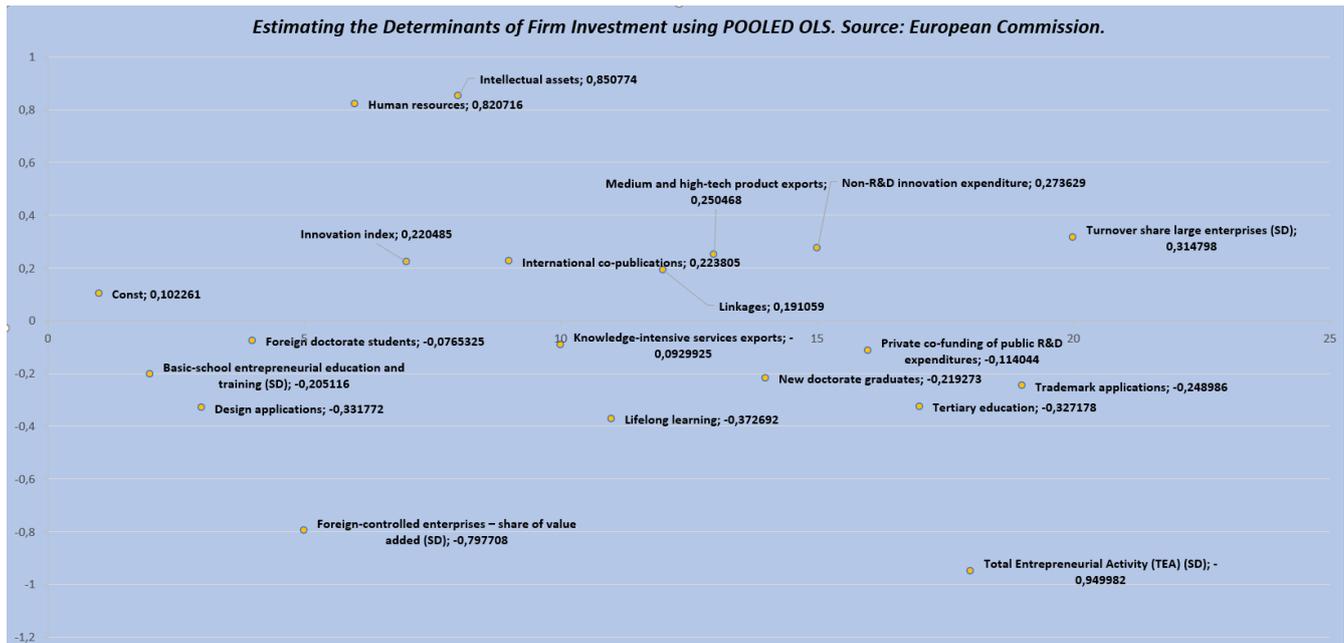


Figure 13. A graphical representation of the Pooled OLS regression. Source: European Innovation Scoreboard-European Commission.

Synthesis of the main results											
		Pooled OLS		Fixed Effects		Random Effects		WLS		Dynamic panel	
	Const	★	0,1023	★	0,135	★	0,12274	★	-0,03	★	-0,65
A4	Basic-school entrepreneurial education and training (SD)	★	-0,205	★	-0,19	★	-0,1937	★	-0,21	★	-0,27
A7	Design applications	★	-0,332	★	-0,212	★	-0,2323	★	-0,34	★	-0,2
A19	Foreign doctorate students	★	-0,077	★	-0,049	★	-0,0557	★	-0,04	★	-0,06
A20	Foreign-controlled enterprises – share of value added (SD)	★	-0,798	★	-0,671	★	-0,6977	★	-0,77	★	-0,59
A23	Human resources	★	0,8207	★	0,874	★	0,86862	★	0,785	★	1,006
A24	Innovation index	★	0,2205	★	0,3133	★	0,29583	★	0,255	★	0,271
A29	Intellectual assets	★	0,8508	★	0,5812	★	0,62934	★	0,847	★	0,499
A30	International co-publications	★	0,2238	★	0,1461	★	0,15795	★	0,227	★	0,161
A31	Knowledge-intensive services exports	★	-0,093	★	-0,085	★	-0,0859	★	-0,12	★	-0,12
A32	Lifelong learning	★	-0,373	★	-0,333	★	-0,3395	★	-0,39	★	-0,33
A33	Linkages	★	0,1911	★	0,2012	★	0,20469	★	0,184	★	0,235
A35	Medium and high-tech product exports	★	0,2505	★	0,2443	★	0,24698	★	0,25	★	0,179
A37	New graduate graduates	★	-0,219	★	-0,243	★	-0,2407	★	-0,22	★	-0,26
A38	Non-R&D innovation expenditure	★	0,2736	★	0,2623	★	0,26317	★	0,266	★	0,278
A43	Private co-funding of public R&D expenditures	★	-0,114	★	-0,101	★	-0,1084	★	-0,08	★	-0,15
A53	Tertiary education	★	-0,327	★	-0,325	★	-0,3266	★	-0,35	★	-0,34
A55	Total Entrepreneurial Activity (TEA) (SD)	★	-0,95	★	-0,676	★	-0,7135	★	-0,66	★	-0,62
A56	Trademark applications	★	-0,249	★	-0,219	★	-0,2241	★	-0,23	★	-0,18
A57	Turnover share large enterprises (SD)	★	0,3148	★	0,2948	★	0,3003	★	0,271	★	0,299
	A18(-1)									★	0,051

Figure 14. Synthesis of the main results. Source: European Innovation Scoreboard-European Commission.

#### 4. Conclusions

We investigate the determinants of the corporate investment in innovation in Europe. We report a short literature analysis that consider the role of R&D intensity for firm performance and growth. Finally, we run an econometric analysis to estimate the determinants of firm investment in innovation in Europe for 36 countries in the period 2000-2019. We found that the probability of a corporation to invest in innovation in Europe is positively associated to: “*Intellectual assets*”, “*Human resources*”, “*Non-R&D innovation expenditures*”, “*Medium and high-tech product exports*”, “*International co-publications*”, “*Innovation index*”, “*Linkages*”. The probability of European corporations to invest in innovation in Europe is negatively associated to “*Foreign doctorate students*”, “*Knowledge-intensive services exports*”, “*Private co-funding of public R&D expenditures*”, “*Basic-school entrepreneurial education and training (SD)*”; “*New doctorate graduates*”, “*Trademark applications*”, “*Tertiary education*”, “*Design applications*”, “*Lifelong learning*”, “*Foreign-controlled enterprises – share of value added (SD)*”, “*Total Entrepreneurial Activity (TEA)*”.

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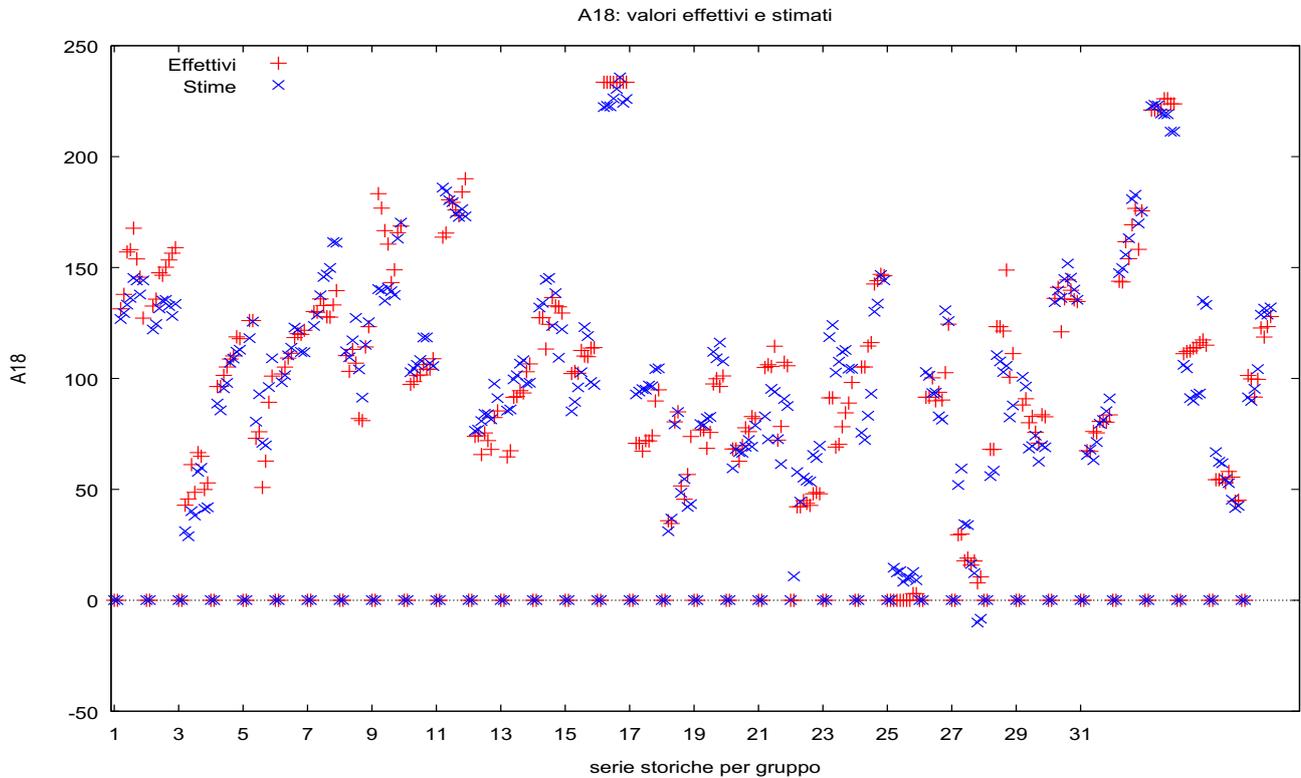
Figure 1. A graphical representation of the Pooled OLS regression. Source: European Innovation Scoreboard-European Commission. ....59

Figure 2. Synthesis of the main results. Source: European Innovation Scoreboard-European Commission. ....59

## 6. Appendix

Pooled OLS, usando 360 osservazioni					
Includere 36 unità cross section					
Lunghezza serie storiche = 10					
Variabile dipendente: A18					
	Coefficiente	Errore Std.	rapporto t	p-value	
const	0,102261	1,42108	0,07196	0,9427	
A4	-0,205116	0,0307653	-6,667	<0,0001	***
A7	-0,331772	0,0308092	-10,77	<0,0001	***
A19	-0,0765325	0,0142587	-5,367	<0,0001	***
A20	-0,797708	0,0581058	-13,73	<0,0001	***
A23	0,820716	0,0537985	15,26	<0,0001	***
A24	0,220485	0,0339522	6,494	<0,0001	***
A29	0,850774	0,0515401	16,51	<0,0001	***
A30	0,223805	0,0222556	10,06	<0,0001	***
A31	-0,0929925	0,0280463	-3,316	0,0010	***
A32	-0,372692	0,0219315	-16,99	<0,0001	***
A33	0,191059	0,0479063	3,988	<0,0001	***
A35	0,250468	0,0268734	9,320	<0,0001	***
A37	-0,219273	0,0265266	-8,266	<0,0001	***
A38	0,273629	0,0143379	19,08	<0,0001	***
A43	-0,114044	0,0401407	-2,841	0,0048	***
A53	-0,327178	0,0217349	-15,05	<0,0001	***
A55	-0,949982	0,167851	-5,660	<0,0001	***
A56	-0,248986	0,0297559	-8,368	<0,0001	***
A57	0,314798	0,0499756	6,299	<0,0001	***
Media var. dipendente	84,48346	SQM var. dipendente	61,26304		
Somma quadr. residui	60121,17	E.S. della regressione	13,29763		

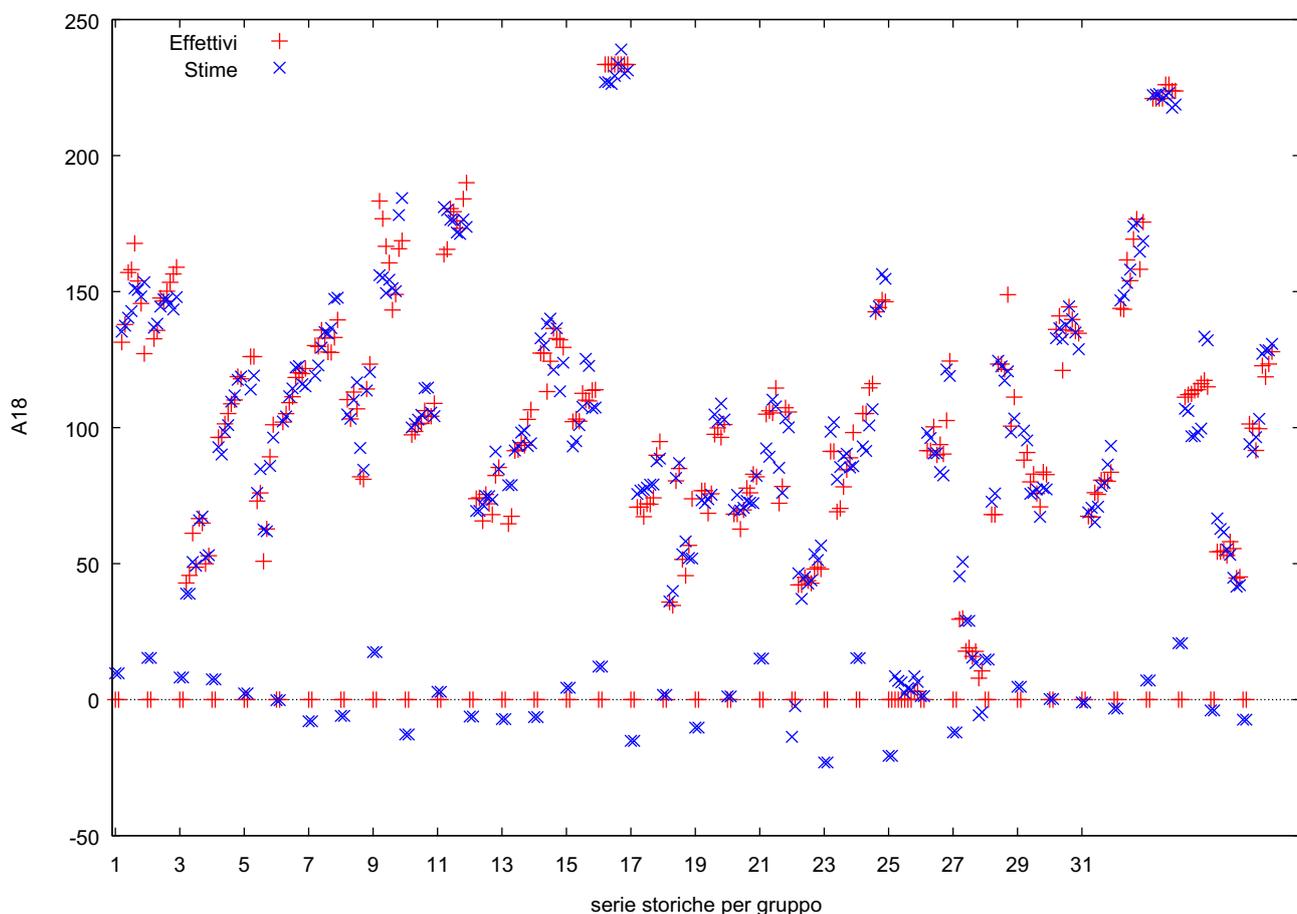
R-quadro	0,955379	R-quadro corretto	0,952886
F(19, 340)	383,1468	P-value(F)	1,7e-216
Log-verosimiglianza	-1432,060	Criterio di Akaike	2904,121
Criterio di Schwarz	2981,843	Hannan-Quinn	2935,024
rho	0,768089	Durbin-Watson	0,518418



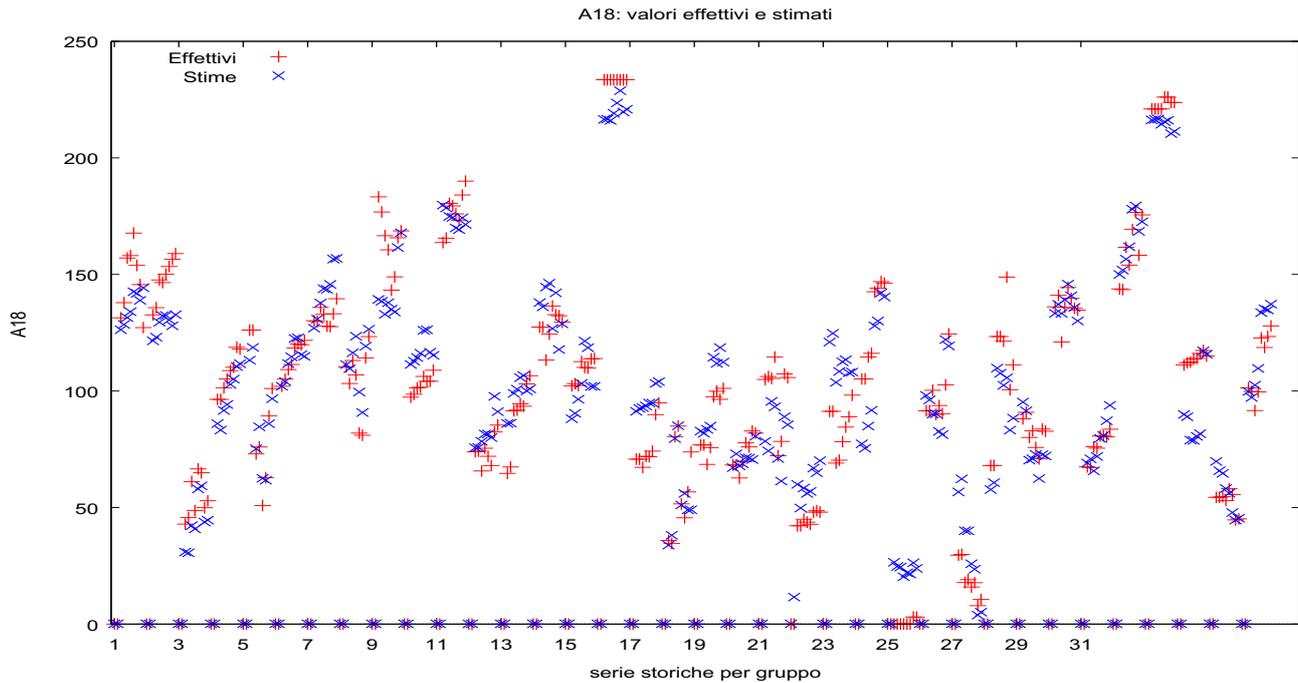
Effetti fissi, usando 360 osservazioni					
Incluse 36 unità cross section					
Lunghezza serie storiche = 10					
Variabile dipendente: A18					
	<i>Coefficiente</i>	<i>Errore Std.</i>	<i>rapporto t</i>	<i>p-value</i>	
const	0,135027	1,11515	0,1211	0,9037	
A4	-0,189534	0,0457851	-4,140	<0,0001	***
A7	-0,212259	0,0351597	-6,037	<0,0001	***
A19	-0,0493911	0,0193649	-2,551	0,0112	**
A20	-0,671159	0,0798313	-8,407	<0,0001	***
A23	0,873968	0,0783475	11,16	<0,0001	***
A24	0,313319	0,0462968	6,768	<0,0001	***
A29	0,581218	0,0658146	8,831	<0,0001	***
A30	0,146092	0,0238445	6,127	<0,0001	***
A31	-0,0847928	0,0407698	-2,080	0,0384	**
A32	-0,332622	0,0301942	-11,02	<0,0001	***
A33	0,201239	0,0538450	3,737	0,0002	***
A35	0,244283	0,0353025	6,920	<0,0001	***
A37	-0,243492	0,0366267	-6,648	<0,0001	***
A38	0,262270	0,0160219	16,37	<0,0001	***
A43	-0,101282	0,0479249	-2,113	0,0354	**

A53	-0,325432	0,0297079	-10,95	<0,0001	***
A55	-0,675597	0,183340	-3,685	0,0003	***
A56	-0,219028	0,0329575	-6,646	<0,0001	***
A57	0,294766	0,0543859	5,420	<0,0001	***
Media var. dipendente	84,48346	SQM var. dipendente	61,26304		
Somma quadr. residui	29018,42	E.S. della regressione	9,754095		
R-quadro LSDV	0,978463	R-quadro intra-gruppi	0,964263		
LSDV F(54, 305)	256,6068	P-value(F)	4,7e-224		
Log-verosimiglianza	-1300,943	Criterio di Akaike	2711,885		
Criterio di Schwarz	2925,621	Hannan-Quinn	2796,871		
rho	0,442061	Durbin-Watson	0,956022		
Test congiunto sui regressori -					
Statistica test: $F(19, 305) = 433,133$					
con p-value = $P(F(19, 305) > 433,133) = 6,47799e-208$					
Test per la differenza delle intercette di gruppo -					
Ipotesi nulla: i gruppi hanno un'intercetta comune					
Statistica test: $F(35, 305) = 9,34021$					
con p-value = $P(F(35, 305) > 9,34021) = 3,68821e-031$					

A18: valori effettivi e stimati

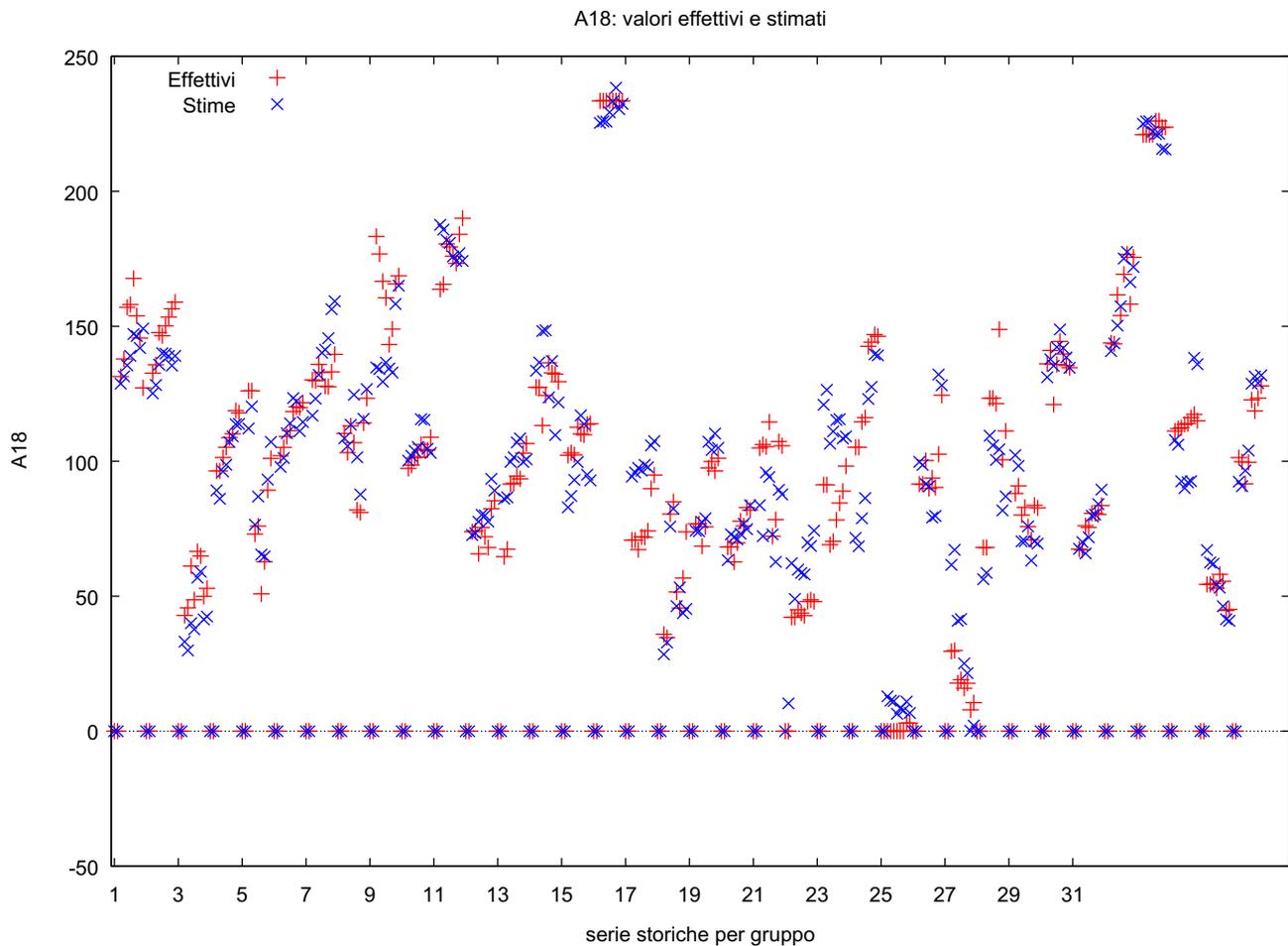


Modello 91: Effetti casuali (GLS), usando 360 osservazioni					
Con trasformazione di Nerlove					
Incluse 36 unit� cross section					
Lunghezza serie storiche = 10					
Variabile dipendente: A18					
	<i>Coefficiente</i>	<i>Errore Std.</i>	<i>z</i>	<i>p-value</i>	
const	0,122743	2,24943	0,05457	0,9565	
A4	-0,193728	0,0411760	-4,705	<0,0001	***
A7	-0,232263	0,0330482	-7,028	<0,0001	***
A19	-0,0557447	0,0177073	-3,148	0,0016	***
A20	-0,697654	0,0728454	-9,577	<0,0001	***
A23	0,868616	0,0706871	12,29	<0,0001	***
A24	0,295828	0,0421476	7,019	<0,0001	***
A29	0,629339	0,0609199	10,33	<0,0001	***
A30	0,157948	0,0225759	6,996	<0,0001	***
A31	-0,0858584	0,0368147	-2,332	0,0197	**
A32	-0,339458	0,0273871	-12,39	<0,0001	***
A33	0,204689	0,0507151	4,036	<0,0001	***
A35	0,246979	0,0324365	7,614	<0,0001	***
A37	-0,240728	0,0333561	-7,217	<0,0001	***
A38	0,263169	0,0151474	17,37	<0,0001	***
A43	-0,108423	0,0447388	-2,423	0,0154	**
A53	-0,326585	0,0270072	-12,09	<0,0001	***
A55	-0,713541	0,173391	-4,115	<0,0001	***
A56	-0,224129	0,0310449	-7,220	<0,0001	***
A57	0,300296	0,0511124	5,875	<0,0001	***
Media var. dipendente	84,48346	SQM var. dipendente	61,26304		
Somma quadr. residui	67580,47	E.S. della regressione	14,07776		
Log-verosimiglianza	-1453,113	Criterio di Akaike	2946,225		
Criterio di Schwarz	3023,947	Hannan-Quinn	2977,129		
rho	0,442061	Durbin-Watson	0,956022		
Varianza 'between' = 120,792					
Varianza 'within' = 80,6067					
Theta usato per la trasformazione = 0,749886					
Test congiunto sui regressori -					
Statistica test asintotica: Chi-quadro(19) = 8775,8					
con p-value = 0					
Test Breusch-Pagan -					
Ipotesi nulla: varianza dell'errore specifico all'unit� = 0					
Statistica test asintotica: Chi-quadro(1) = 259,102					
con p-value = 2,693e-058					
Test di Hausman -					
Ipotesi nulla: le stime GLS sono consistenti					
Statistica test asintotica: Chi-quadro(19) = 10,5737					
con p-value = 0,937347					



Modello 92: WLS, usando 360 osservazioni					
Incluse 36 unità cross section					
Variabile dipendente: A18					
Pesi basati sulle varianze degli errori per unità					
	<i>Coefficiente</i>	<i>Errore Std.</i>	<i>rapporto t</i>	<i>p-value</i>	
const	-0,0318570	0,975417	-0,03266	0,9740	
A4	-0,206543	0,0179554	-11,50	<0,0001	***
A7	-0,341205	0,0249589	-13,67	<0,0001	***
A19	-0,0386783	0,0104116	-3,715	0,0002	***
A20	-0,771054	0,0433407	-17,79	<0,0001	***
A23	0,784972	0,0416887	18,83	<0,0001	***
A24	0,255491	0,0307416	8,311	<0,0001	***
A29	0,847148	0,0467390	18,13	<0,0001	***
A30	0,227350	0,0152700	14,89	<0,0001	***
A31	-0,119252	0,0220984	-5,396	<0,0001	***
A32	-0,394969	0,0165223	-23,91	<0,0001	***
A33	0,184159	0,0354649	5,193	<0,0001	***
A35	0,249531	0,0189533	13,17	<0,0001	***
A37	-0,215009	0,0171880	-12,51	<0,0001	***
A38	0,265618	0,0105306	25,22	<0,0001	***
A43	-0,0757807	0,0292916	-2,587	0,0101	**
A53	-0,352558	0,0174342	-20,22	<0,0001	***
A55	-0,657238	0,147322	-4,461	<0,0001	***
A56	-0,226607	0,0254036	-8,920	<0,0001	***
A57	0,270514	0,0317873	8,510	<0,0001	***
Statistiche basate sui dati ponderati:					
Somma quadr. residui	327,7706	E.S. della regressione	0,981851		
R-quadro	0,981540	R-quadro corretto	0,980509		
F(19, 340)	951,4933	P-value(F)	1,5e-281		
Log-verosimiglianza	-493,9357	Criterio di Akaike	1027,871		

Criterio di Schwarz	1105,593	Hannan-Quinn	1058,775
Statistiche basate sui dati originali:			
Media var. dipendente	84,48346	SQM var. dipendente	61,26304
Somma quadr. residui	63680,20	E.S. della regressione	13,68557

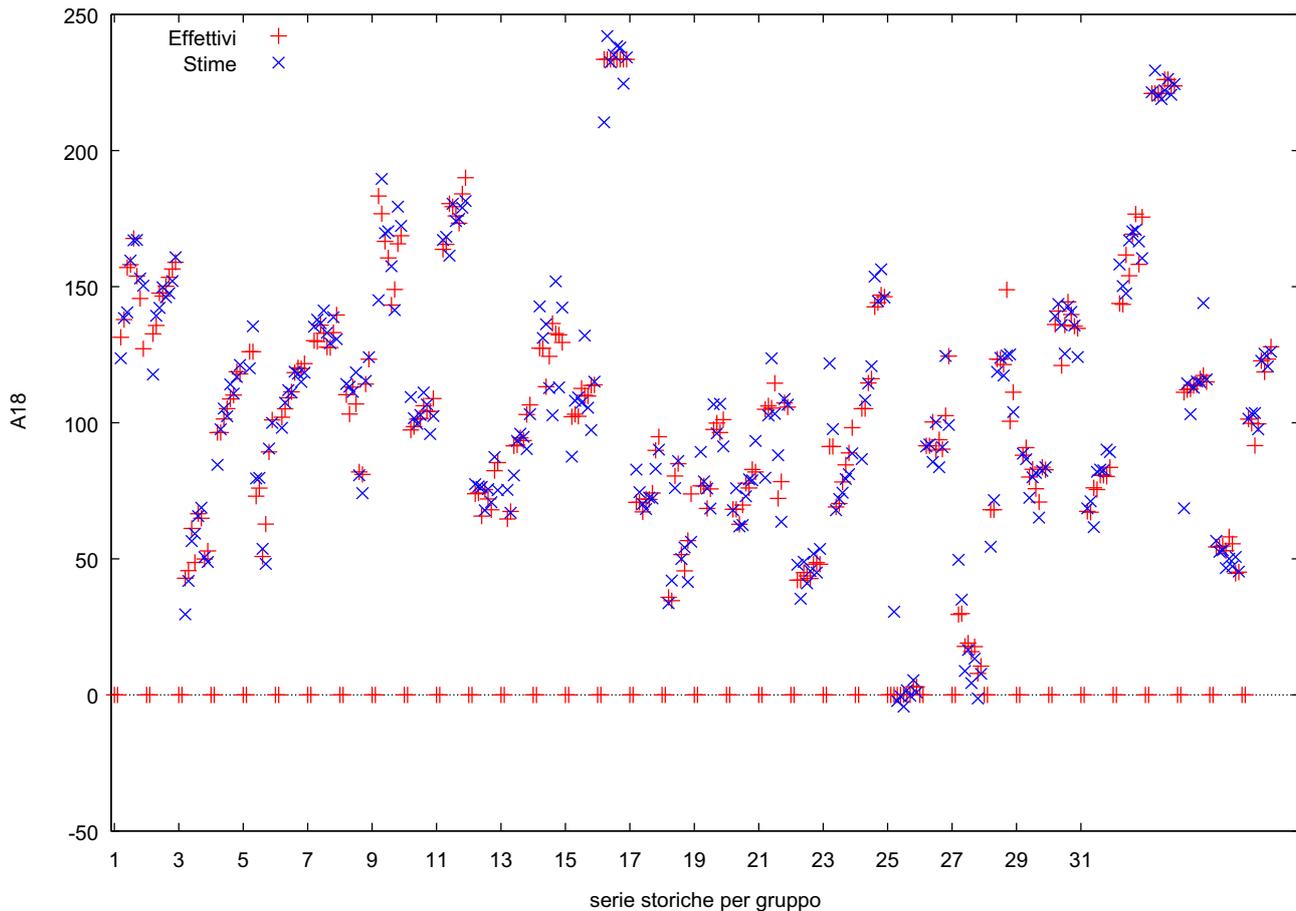


Modello 94: Panel dinamico a un passo, usando 288 osservazioni

Incluse 36 unità cross section					
Matrice H conforme ad Ox/DPD					
Variabile dipendente: A18					
	<i>Coefficiente</i>	<i>Errore Std.</i>	<i>z</i>	<i>p-value</i>	
A18(-1)	0,0396763	0,0203641	1,948	0,0514	*
const	-0,649042	0,681191	-0,9528	0,3407	
A4	-0,272938	0,0524163	-5,207	<0,0001	***
A7	-0,203129	0,0557553	-3,643	0,0003	***
A19	-0,0615031	0,0312912	-1,966	0,0494	**
A20	-0,588928	0,192403	-3,061	0,0022	***
A23	1,00568	0,202832	4,958	<0,0001	***
A24	0,270533	0,0787369	3,436	0,0006	***
A29	0,498735	0,128941	3,868	0,0001	***
A30	0,161308	0,0410625	3,928	<0,0001	***
A31	-0,115130	0,0531642	-2,166	0,0303	**

A32	-0,327066	0,0782227	-4,181	<0,0001	***
A33	0,234847	0,0677341	3,467	0,0005	***
A35	0,179467	0,0656409	2,734	0,0063	***
A37	-0,261322	0,0859418	-3,041	0,0024	***
A38	0,278273	0,0213525	13,03	<0,0001	***
A43	-0,150148	0,0579174	-2,592	0,0095	***
A53	-0,342374	0,0703057	-4,870	<0,0001	***
A55	-0,623954	0,331483	-1,882	0,0598	*
A56	-0,177840	0,0633097	-2,809	0,0050	***
A57	0,298799	0,0851788	3,508	0,0005	***
Somma quadr. residui	26808,72	E.S. della regressione	10,02034		
Numero di strumenti = 41					
Test per errori AR(1): $z = -2,41267$ [0,0158]					
Test per errori AR(2): $z = 1,29273$ [0,1961]					
Test di sovra-identificazione di Sargan: Chi-quadro(20) = 14,9784 [0,7776]					
Test (congiunto) di Wald: Chi-quadro(20) = 6095,71 [0,0000]					

A18: valori effettivi e stimati



# The importance of the port of Rijeka within the Pan-European corridor V

Lorena Bogović<sup>1</sup>, Marija Jović<sup>2</sup>, Edvard Tijan<sup>3</sup>, Ana Perić Hadžić<sup>4</sup>

<sup>1</sup>Student, University of Rijeka, Faculty of Maritime Studies, Croatia

<sup>2</sup>Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia

<sup>3</sup>\*Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia

<sup>4</sup>Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia

\*Corresponding Author: e-mail: etijan@pfri.hr

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## Abstract

In this paper, the role of seaports in the transport system was explained, as the hubs which connect various transport modes (road, rail, sea) for both cargo and passengers. The Pan-European Corridor V was analyzed, as a part of the Pan European Transport Network, consisting of seaports, roads and railroads, established in order to facilitate the European and Pan European traffic. The statistical data for port of Rijeka, the largest Croatian cargo seaport was compiled, emphasizing the importance within the Croatian seaport system, and within the Pan-European Corridor V. The Port of Rijeka was compared with the Ports of Venice, Trieste and Koper, which also lie at the Pan-European Corridor V. Finally, the analysis of the Corridor V branches B (Port of Rijeka) and C (Port of Ploče) was conducted.

*Keywords:* Maritime transport, Pan-European Transport Network, Corridor V, seaports, Port of Rijeka

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## 1. Introduction

The term transport refers to the movement of cargo from initial to end point, more specifically from the point of production, to the consignee of the cargo. It is necessary to form a balance between transport activities to achieve the lowest costs, but by fulfilling the required conditions. To achieve that, it is required to form a transport chain which will transport the goods in the fastest, safest and the most economical way.

The Geo-traffic position of Croatia is considered to be the key factor for its traffic valorization. Besides the position at the intersection of some important traffic corridors, Croatia is located on the Adriatic coast, deeply into the European mainland. This fact proves that the North Adriatic transport route is the shortest route connecting Europe to Mediterranean and to most Asian countries via Suez Canal (Dundović, Vilke, & Šantić, 2010). Central European Transport Corridor, which connects Northern Europe (Baltic) to the Southern Europe through Central Europe, is important for the Adriatic ports and their traffic. Adriatic ports are also located on the South European Transport Corridor, which provides connections for Mediterranean (Dundović et al., 2010).

The port of Rijeka is located on the intersection of important European corridors, both road and rail corridors, which makes it the optimal port in Croatia for receiving the goods and their further transportation to Central and Eastern Europe. The port of Rijeka is an important part of most transport chains which begin in the Middle East and end in Eastern and Central Europe, even in Northern Europe. The reason for that is the excellent position of the port of Rijeka at the top of the Kvarner Bay, where the Adriatic Sea is the deepest into the European mainland. The other reason is Rijeka being the capital and the largest city of the Primorje-Gorski Kotar County.

Due to the aforementioned characteristics, the topic of this paper is the importance of the port of Rijeka in the transport chain within the Pan-European corridor V and its advantages in relation to the other ports, such as Venice, Trieste, Koper and Ploče.

## 2. The role of seaports in the transport system

The transport sector, as a part of international trade, can be viewed as a part of the public infrastructure, a supply chain, a service provision or a business. The transport sector is handling both passenger and freight transport (Westerheim, 2014). Transportation represents the largest share of total logistics costs, and involves numerous stakeholders (Jović, Tijan, Karanikić, & Perić Hadžić, 2020). The development of transport services and an adequate transport and communication infrastructure are increasingly becoming important in achieving the competitive edge and decidedly influence the position of a country in international trade (Pavlović & Radoš, 2016).

Maritime transport involves a large number of stakeholders as well such as ship owners, insurance companies, agents, etc., and numerous business procedures and interests (Marx, Gebhard, Jović, & Tijan, 2019). Seaports are main links in the international maritime transport, offering various services and connecting many stakeholders (Agatić & Kolanović, 2020). A seaport may also be defined as a logistic and industrial node accommodating seagoing vessels and characterized by a functional and spatial clustering of cargo transport, storage, and transformation processes linked to global supply chains (Notteboom, Lugt, Saase, Sel, & Neyens, 2020). Seaports must adapt constantly to contemporary business conditions in order to remain competitive in the global market (Tijan, Jović, Jardas, & Gulić, 2019). In this respect, seaports should conduct their operations according to principles or aspects of sustainability: the economic principle (providing seaport services efficiently), the environmental

principle (efficient use of natural resources, decreased emission of pollutants, etc.), and the social principle (well-being of seaport employees and stakeholders) (Tijan, Agatić, Jović, & Aksentijević, 2019).

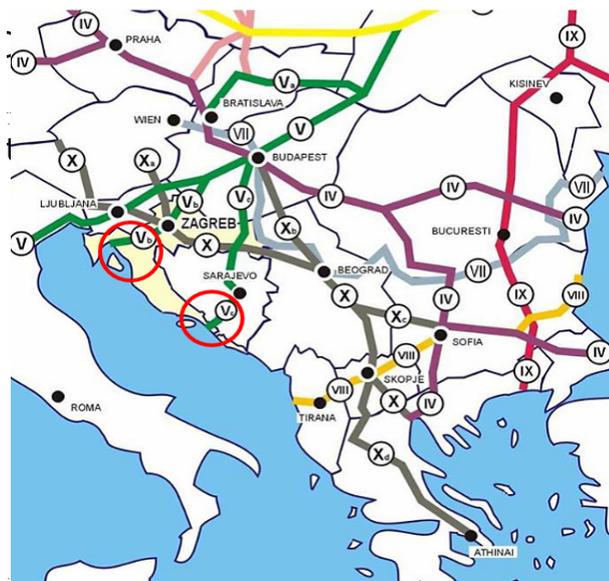
One of the main roles of seaports is providing the services for passengers, cargo and ships. In the distribution process, the seaport is not the initial or the end point of the transport chain. In the seaports, the cargo is reloaded from the ships to the other means of transport. Also, the cargo which is loaded on the ships has arrived at the seaport by the other types of inland transport. According to that, an important role of seaports is connecting different transport modes in the transport of the cargo and passengers, since the seaports are initial and end points of maritime routes and rail and road corridors (Poletan Jugović, 2014).

The continuous development of logistics chains and their network system is possible due to the developed node-link system, where the most important nodes are seaports and integrated logistics centres (Montwiłł, 2014). Therefore, seaports have also become key elements of distribution systems in highly urbanized areas focused on the spatial range of services related to the transport, forwarding and logistics to optimize supply, which leads to the reduction in congestion and other external costs of transport (Montwiłł, 2014).

### 3. Corridor V as a part of the Pan-European transport network

Pan-European Network is a road and rail system connecting Europe. It is organized to improve international traffic in Europe and between Europe and Asia. The European Union had a goal to expand Trans-European Network by the development of the Pan-European Network, so the Northern Europe could connect with the Eastern, Southeastern and Central Europe (Poletan Jugović, 2014). Pan-European Network consists of ten corridors. None of them are based in one country only, since there a condition exists that each corridor must be located in at least three countries which are a part of the European Union and each corridor must cross at least two borders (Ministry of Maritime Affairs Transport and Infrastructure, n.d.). Also, each corridor must have at least three types of infrastructure. The corridors were formed at the European Conference of Ministers of Transport in Prague (1991), Crete (1994) and Helsinki (1997) (Dundović & Grubišić, 2013).

Some of the Pan-European corridors are located in the Republic of Croatia (Božičević, Steiner, & Smrečki, 2008) as shown in the Figure 1. One of them is Corridor VII, also known as the Rhine-Danube Corridor. The other one is Corridor X, Branch Xa, which connects Graz, Maribor and Zagreb. The third one is Corridor V, the most important corridor for the port of Rijeka.



**Figure 1.** Pan-European Corridor V

The Corridor V connects Venice, Trieste and Koper, Ljubljana, Budapest, Bratislava, Uzhhorod and Lviv (Prometna zona, n.d.). Besides the main branch, Corridor V has three more branches:

- Corridor Va: Bratislava – Žilina – Košice - Uzhhorod
- Corridor Vb: Rijeka – Zagreb - Budapest
- Corridor Vc: Ploče – Mostar – Sarajevo – Osijek - Budapest

There are two branches located in Croatia, Branch Vb and Branch Vc. For the port of Rijeka, the most important corridor is Corridor Vb since it connects the port of Rijeka to the Pan-European Network. The port of Rijeka is also important for the Corridor Vb since it is the initial and the end point of this branch, and also the only port on the branch. But, the port of Rijeka is not the only port on the Corridor V. There is the port of Ploče (also Croatian port) on the Corridor Vc and Italian ports of Trieste and Venice and Slovenian port of Koper on the main branch of the Corridor V.

#### 4. Port of Rijeka as the key part of Croatian seaport system

Port of Rijeka is the largest cargo port in Croatia. It is located at the northern coast of the Republic of Croatia. Port of Rijeka consists of numerous cargo terminals and a passenger terminal. Besides that, the port provides different types of services to the ships, passengers and cargo and it has an optimal geo-traffic position. All of that makes the port of Rijeka the largest port in Croatia and one of three North Adriatic ports (including the port of Trieste and the port of Venice), which compete with the North Sea ports in maritime transport of the cargo to the Central Europe (Marković, Muić, & Vučić, 2003).

Port of Rijeka is connected to the inland by road and by rail. Corridor Vb, which connects Rijeka, Zagreb and Budapest, has an important role in connecting the port of Rijeka to the inland. Since the port of Rijeka is the only port on the Corridor Vb, it has an important role in diverting the cargo onto the Corridor V. Cargo unloaded in the port of Rijeka is transported to the end points in the inland on the Corridor V and Corridor Vb. Corridor Vb connects Rijeka to Zagreb, the capital city of Croatia, so the transportation of cargo from the port of Rijeka to the end points in Central and Eastern Croatia and in Eastern Europe is directed to the infrastructure of the Corridor Vb, which connects to the main branch of the Corridor V in Budapest.

CEF (Eng. *Connecting Europe Facility*) co-finances projects for infrastructure development in the port of Rijeka, which proves the importance of the port of Rijeka on the Corridor V. The goal is to improve port infrastructure of the port of Rijeka, also the rail infrastructure, port intermodality and other important elements. CEF finances those projects because of the significance of the port of Rijeka is a part of the Pan-European Network via Corridor V. Infrastructure improvement projects in the port of Rijeka are (Port of Rijeka Authority, 2020):

- Development of multimodal platform
- Port Community Information System improvement
- Zagreb Deep Sea Container Terminal
- Rijeka Basin infrastructure improvement
- Bulk cargo terminal Bakar infrastructure improvement
- General cargo terminal infrastructure improvement
- Adriatic Gate Container Terminal dredging

The main goal of those projects is to modernize the infrastructure and terminals for handling different types of cargo. By improving the infrastructure and terminals, the cargo volume on the port of Rijeka's transport routes should grow, as well as on the Corridor V.

#### 5. The comparison of the port of Rijeka with ports of Venice, Koper, Trieste and Ploče

Besides the port of Rijeka, there are four more ports on the Corridor V: Trieste, Koper and Venice, which are located on the main part of the Corridor V and the port of Ploče, located on the Corridor Vc.

Port of Ploče is an important Croatian port on Corridor Vc, which connects Ploče, Mostar, Sarajevo, Osijek and Budapest. Port of Ploče is the only port on the Corridor Vc. It is a universal port for handling almost all types of cargo (Port of Ploče Authority, n.d.-b). That is why the port is equipped with equipment and mechanization for docking different types of ships and for loading various types of cargo. The port is located at the southern coast of Croatia, and as such is very important for the economy of Bosnia and Herzegovina, because Corridor V, more specifically Branch Vc connects Ploče to Sarajevo, Osijek and Budapest, where Corridor Vc connects to the main branch of the Corridor V (Port of Ploče Authority, n.d.-a).

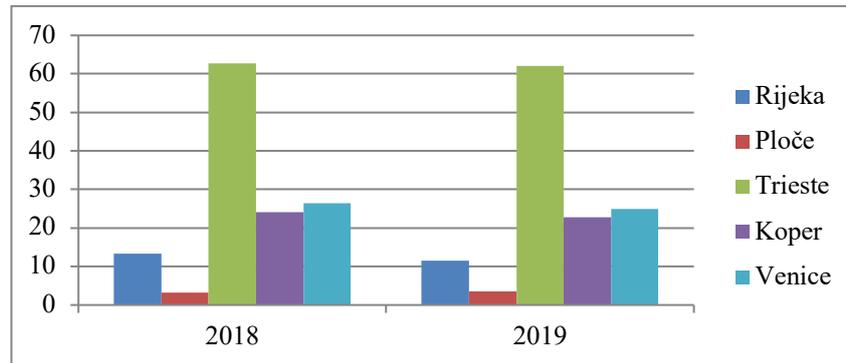
Port of Rijeka and port of Ploče are two out of five ports important on the Corridor V. Other ports are Italian ports of Trieste and Venice and Slovenian port of Koper. Port of Venice is the initial point of the main branch of the Corridor V, located in the Northwestern Adriatic. Port of Venice is important for passenger shipping, especially cruising. Furthermore, the port also has terminals for handling different types of cargo, such as general cargo, containers, liquid and bulk cargo (Port of Venice, n.d.). Venice is the westernmost point of the Corridor V and its initial point. Corridor V connects Venice to Trieste and Koper.

Port of Trieste (Italy) and port of Koper (Slovenia), including the port of Rijeka, are known as North Adriatic ports (Marković et al., 2003). All three ports have similar geo-traffic position and are a part of the Corridor V. Container traffic is important for those ports since they have equipment, mechanization and infrastructure specialized for handling containers. Besides the container traffic, port of Trieste and port of Venice are specialized for handling other types of cargo.

The ports on the Corridor V could be compared based on a few criteria. One of them is their position on the Corridor V. Port of Venice is the westernmost point on the Corridor V. As already mentioned, it is the initial and the end point of the main branch of the Corridor V. Port of Trieste and port of Koper are also located on the main branch of the Corridor V. For those ports, the Corridor V is the direct connection to the Venice. The two ports have similar geo-traffic position since they are positioned very close to each other. Port of Rijeka has a very similar geo-traffic position as the two ports, but unlike them, the port of Rijeka has a different position on the Corridor V. Port of Rijeka is the initial and the end point of the Corridor Vb, and also the only port on this branch. Port of Ploče is the southernmost point on the Corridor V. As the port of Rijeka, the port of Ploče is located on the branch of the Corridor V, which is the Corridor Vc. Port of Ploče is the only port on the Corridor Vc, also its initial and end point.

The other basis for comparison is the cargo volume of the ports, with the presumption that a part of the cargo volume is directed to the Corridor V to be transported to the end point of the transport chain. The comparison of the ports on Corridor V based on the cargo volume is shown in the Figure 2 (Autorità di Sistema Portuale del Mare Adriatico Orientale Porti di Trieste

e Monfalcone, n.d.), (North Adriatic Sea Port Authority, n.d.), (Port of Koper, n.d.), (Port of Ploče, n.d.), (PortSEurope, 2019), (Port of Rijeka Authority, n.d.).



**Figure 2.** Total cargo volume in the ports on the Corridor V 2018-2019 [mil t]

Figure 2 shows the total cargo volume in the ports on the Corridor V. Cargo volume is shown in million tons in years 2018 and 2019. In both years, the port of Trieste has had the largest cargo volume, which is about 60 million tons (Autorità di Sistema Portuale del Mare Adriatico Orientale Porti di Trieste e Monfalcone, n.d.). The port of Venice has had a cargo volume of 25 million tons (North Adriatic Sea Port Authority, n.d.). The third port is the port of Koper, with cargo volume around 23 million tons (Port of Koper, n.d.). During this period, port of Rijeka has had a cargo volume of 12 million tons (Port of Rijeka Authority, n.d.). Port of Ploče has had the lowest cargo volume (PortSEurope, 2019). During this period, it was around 3 million tons (Port of Ploče, n.d.).

This information is representative for maritime transport only, since all of the cargo was transported to the ports by ships. In this case, port of Trieste has the largest cargo volume, but that does not mean that the port of Trieste is the most important port for the Corridor V. That is because not all of that cargo is directed to Corridor V to be transported to the inland, a large percentage of the cargo is used locally, due to the intensive industrial sector in the region. Nevertheless, the way the port operates is important for the corridor since the quality of the port services and port profitability lead to larger profitability of the corridor as a whole.

## 6. The importance of the port of Rijeka in comparison to the port of Ploče)

There are two ports in Croatia which are situated on one of the Pan-European corridors: port of Rijeka and port of Ploče. Both of these ports are located on the branches of the Corridor V. The importance of the port of Rijeka and the port of Ploče could be compared based on a few characteristics. In the Croatian seaport system, both port of Rijeka and port of Ploče are ports opened for public traffic of international economic importance (there are six ports of this type in Croatia). The port of Rijeka is the largest and the most important port in Croatia.

Port of Rijeka is (compared to the port of Ploče) more important for Corridor V for several reasons. It is the largest Croatian port, and has got the largest cargo volume in Croatia. For instance, in the year 2019, total cargo volume in the port of Rijeka was 11,49 million tons. On the other hand, in the port of Ploče the total cargo volume was 3,56 million tons. These statistics show that the cargo volume of the port of Rijeka is two times larger than the cargo volume of the port of Ploče.

Containers are one of the most important types of cargo handled at the port of Rijeka. Twenty years ago, the average yearly container volume at the port of Rijeka was 15000 TEU. Currently, the yearly container volume is 300000 TEU, meaning that the volume is growing rapidly. Intensive growth of cargo volume is also expected in the future, especially in the container traffic. Expected container volume in the year 2025 is 600000 TEU (Ministry of Maritime Affairs Transport and Infrastructure, 2017).

The expectation of the cargo volume growth of the port of Rijeka is based on the infrastructure improvement projects. Zagreb Deep Sea Container Terminal project is the most important for the container volume growth. It is a new container terminal at the northern part of the port of Rijeka. The planned capacity of the container terminal is 650000 TEU per year and the sea depth should be 20 meters, which would allow the docking of large container ships (Ministry of Maritime Affairs Transport and Infrastructure, 2017). Zagreb Deep Sea Container Terminal is shown in the Figure 3 (Ministry of Maritime Affairs Transport and Infrastructure, 2017).



**Figure 3.** Zagreb Deep Sea Container Terminal

The two ports could also be compared to each other based on their location. Both of them are located on the branches of the Corridor V. Port of Rijeka is situated on the Corridor Vb, while the port of Ploče is situated on the Corridor Vc. Port of Rijeka and port of Ploče are the only ports on their branches. Corridor Vb is located close to the main branch of the Corridor V. Also, the port of Rijeka is located near the Italian and Slovenian ports on the Corridor V. Unlike the port of Rijeka, the port of Ploče is not located close to the main branch of the Corridor V. It is also the southernmost point of the Corridor V.

Port of Rijeka and Corridor Vb have different importance for Croatia, compared to the importance of the port of Ploče and Corridor Vc. Corridor Vb is mostly located in Croatia. It connects the port of Rijeka to the capital city of Zagreb, after which it connects Zagreb to Budapest in Hungary. That means that the Corridor Vb is located in Croatia and Hungary, but mainly in Croatia. At the same time, it connects the largest Croatian port to the largest city and capital city of Croatia. On the other hand, Corridor Vc is located in Croatia, Hungary and Bosnia and Herzegovina, but mostly in Bosnia and Herzegovina. The branch connects the port of Ploče to the Croatian city of Osijek, but through the territory of Bosnia and Herzegovina. In Croatia, both port of Rijeka and Corridor Vb are more important than the port of Ploče and Corridor Vc.

Since there is a large connection between the expected growth of the traffic volume in the port of Rijeka and the projects, which are financed because of the port of Rijeka being the initial and the end point of the Corridor Vb, the growth of traffic volume and improvement of the infrastructure should bring the advantages to the port of Rijeka and to the Corridor V too, as it is the most important corridor for directing the cargo from the port of Rijeka to the inland. According to this information, port of Rijeka is the most important Croatian port on the Corridor V. At the same time, Branch Vb is the most important branch of the Corridor V in Croatia.

## 7. Conclusion

Traffic system is a complex system which consists of different transport modes, their elements and connections between them. Transport modes are subsystems of the traffic system. Transport of the cargo often includes various means of different modes of transport. That means that the elements of different transport modes affect each other. Seaports are one of the traffic systems elements. They are places where the cargo is loaded from the ships to the other transport modes. Also, the cargo arriving at the port by the sea is transported to the end point by the other modes of transport, which means that the ports direct the cargo to land corridors for further transport.

Port of Rijeka is the largest Croatian cargo port. It allows the transport of the cargo between Croatia and other countries in the hinterland and oversea destinations. Port of Rijeka is one of the two Croatian ports which are a part of Pan-European Network. It is located on the important transport route, which is the Corridor V, Branch Vb of the Pan-European Network. Port of Rijeka is important for the Corridor V since it is one of the ports on the corridor and the only port on the Corridor Vb. Besides the port of Rijeka, there are ports of Venice, Koper and Trieste on the main branch of the Corridor V and the port of Ploče on the Corridor Vc.

As the initial and the end point of the Corridor Vb, the port of Rijeka allows directing the cargo on the Corridor V. At the port of Rijeka, large amounts of cargo are unloaded from ships (and vice versa) since it is the largest cargo port in Croatia. Corridor V is the most important land corridor for transporting the cargo from the port of Rijeka to the inland. According to all of that, the traffic at the port of Rijeka affects the traffic on the Corridor V, especially on the Corridor Vb.

Cargo volume of the port of Rijeka is expected to grow. For instance, container volume is expected to double itself in the near future. There are also projects planned for the development and modernization of the port infrastructure. The projects should result in the growth of the cargo volume and importance of the port of Rijeka in cargo transport. The connection between the port of Rijeka and the Corridor V is one of the reasons for planning the projects. CEF co-finances the projects for infrastructure improvement at the port of Rijeka since the port of Rijeka is the only port on the Corridor Vb. That means that the projects should bring advantages to both the port of Rijeka and the Corridor V.

The conclusion is based on the projects planned in the port of Rijeka and the importance of the port compared to the other ports on the Corridor V. Great inputs are used for the improvement of the infrastructure at the port of Rijeka, by the projects which should result in cargo volume growth. One of the projects is the construction of the Zagreb Deep Sea Container Terminal with the expected annual capacity of 650000 TEU, which is double compared to the actual annual container turnover at the port

of Rijeka. Comparison of the port of Rijeka to the other ports on the Corridor V shows that the other ports have larger cargo volume than the port of Rijeka. Although the port of Rijeka has smaller cargo volume, the port of Rijeka directs almost all of its cargo on the Corridor Vb. Since the traffic in the port of Rijeka is expected to grow, the traffic on the Corridor V should increase too, since it is the most important corridor connecting the port of Rijeka and its hinterland.

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# Electronic transportation management system development in the port of Rijeka

Edvard Tijan<sup>1</sup>, Marija Jović<sup>2</sup>, Saša Aksentijević<sup>3</sup>, Dražen Žgaljić<sup>4</sup>

<sup>1</sup>*Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia*

<sup>2</sup>*Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia*

<sup>3</sup>*Aksentijević Forensics and Consulting, Ltd, Croatia*

<sup>4</sup>*Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia*

\*Corresponding Author: e-mail: [etijan@pfri.hr](mailto:etijan@pfri.hr)

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## Abstract

When transportation systems are inadequately managed, increased costs or missed opportunities may arise. Developed seaports should aim to implement the platforms that allow smooth electronic data exchange, such as electronic Transportation Management Systems. One of the disadvantages of the existing electronic Transportation Management Systems in the Port of Rijeka is the inability of remote user access. This can be partially remedied in several ways (VPN connections, etc.), but the idea was to allow users to both work from remote locations and to use mobile devices. As a part of the research, an improved Transportation Management System in the Port of Rijeka was suggested, with the ability to work from remote locations and with the support for mobile devices, using cloud delivery. Such electronic Transportation Management System should enable users to optimize their business processes by connecting various seaport stakeholders, providing tangible sustainability benefits (mainly ecological and economic). Efficient communication between all the participants in the cargo chain will reduce the negative effects of cargo traffic on the environment, such as idle time and traffic jams. The optimization of transport routes and the simplification of the entire transport process will have a long-term impact on the operations in the Port of Rijeka. Besides the positive effects on companies, it will also benefit the employees and the local community.

*Keywords:* Electronic Transportation Management Systems, Seaports, Port of Rijeka, Digitalization, Business Process Optimization

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## 1. Introduction

Transport documents lie at the heart of international trade transactions. To the shipping company, freight transport documents provide an accounting ledger of the transactions, instructions on where and how to ship the goods and a statement giving instructions for handling the shipment (Global Negotiator, n.d.). The paper documents which are exchanged between seaport stakeholders and the necessity of physical presence during the so-called “coordination meetings” slow down the business processes and produce higher costs.

Digitalization in transport is a driver for efficiency, simplification, lowering costs, and a better use of resources and existing infrastructures and may improve the way cargo and traffic flows can be organized and managed in the future (CLECAT, 2017). In the maritime transport sector, especially in seaports, the digitalization process is slow, and this sector is among the weakest digitalized sectors (Smokvina, 2018). Common issues in less developed seaports are the following: lack of awareness of the importance of the transportation management system development; lack of integrated e-business platforms covering all business processes; certain stakeholders are not sufficiently integrated into the transport chain (Jović, Tijan, Aksentijević, & Sotošek, 2019).

Port of Rijeka represents an intermodal port, and a multi-purpose port as well, where the port activities are performed at several locations and terminals (Jović, Kavran, Aksentijević, & Tijan, 2019). Furthermore, a major role in the success of the port is played by its traffic connections with the rest of the country as well as the surrounding countries. Therefore, Port of Rijeka should provide capacities to successfully respond to the demand. However, the success of the Port of Rijeka does not depend only on its traffic connections, and in order to improve its service, Port of Rijeka needs to digitalize its business processes. The Port of Rijeka could be more competitive if the level of digitalization is increased.

Electronic Transportation Management System (e-TMS) may be defined as an electronic platform or integrated business system which streamlines the business processes, improves stakeholder collaboration, enables improved execution of transport activities, and simplifies monitoring of any physical or administrative operation (Tijan, Jović, & Karanikić, 2019). Although the electronic Transportation Management Systems provide various benefits, certain disadvantages related to e-TMS exist. Not all software systems are designed with the same features or service models, so it is possible to end up with a system that is not tailored to the needs of the company, and adapting to the specific requirements can be expensive (Oberge, 2020). Furthermore, Transportation Management Systems may lack a uniform data transferring capability and storage format in order to achieve data

sharing and integration functionalities (Xu, Zhen, Li, & Yue, 2017). Planning, organizing, contracting (operational and financial), execution and tracking of transport is generally realized and supervised by the use of multiple types of auxiliary tools, with one of the most important tools being the software support. A specialized software category – e-TMS - enables efficient planning and organizing of transport, tracking goods from origin to destination, and the optimization of all related procedures. The possibility of timely collection of quality information in all transport steps is of paramount importance in the planning and organization of transport, and the transport of goods itself.

## 2. Electronic Transportation Management System in Port of Rijeka

As stated before, electronic Transportation Management System is an integrated business system designed to monitor business processes in the transport logistics chain. In the Port of Rijeka numerous stakeholders have to cooperate closely, such as: shipping companies, truck and rail carriers, terminal operators, customs, port authorities, and other stakeholders depending on the nature of the cargo, mode of transport and other characteristics of each transport process. An effective electronic Transportation Management System should help users to act effectively, and efficiently monitor the progress of the transport process, which should be achieved through the integration of functions and interfaces towards other participants in the transport process.

In the Port of Rijeka, the existing electronic Transportation Management System has been developed as a desktop application in a 'two - tier' architecture, and as such has been installed and used by users in a work environment. One of the drawbacks of the current electronic Transport Management Systems is that remote user access is not possible. This can be partially offset in several ways (VPN connection, RDP mode, etc.), however none of the methods can effectively allow users to work from remote locations and use mobile devices. The improved version should be created as an Internet application. Cloud based e-TMS should duplicate individual software modules and functions, which should be available to users in both ways, through desktop and cloud versions of the application. The cloud version should use the business logic from the desktop version of the application, but also customize and optimize the functionalities respecting the common rules and standards for that type of application. Both versions should allow the data, entered via either version, to be completely further processed in any version, during any step in the business process. In this way, the end users will be able to optimize their business processes. System functionalities of the proposed e-TMS solution in the Port of Rijeka should be the following:

- Traffic overview (in TEU) for the import and export of goods
- Traffic overview (in TEU) for the import of goods by shipping companies
- Traffic overview (in TEU) by customers according to issued invoices for maritime transport
- Overview of work performed according to organizational units of the company
- Review of work performed in a certain period of time (monthly and annually)
- Review of work performed by employees
- Review of work performed by business partners
- Traffic overview (in TEU) by employees and organizational units of the company
- Traffic overview (in TEU) by business partners
- Overview of turnover (in TEU) by employees and organizational units of the company on the basis of orders issued to container terminal
- Review of traffic (in TEU) by business partners based on issued orders to the container terminal
- Data review and data manipulation, according to the current status of the data for each ship's voyage
- Review of entered documents and the possibility of changing the data on individual documents, in accordance with the current status of the document

Statistical reviews in container traffic should show the traffic data, especially in the direction of import and export of goods. The basic criterion is the period, within which the traffic on individual voyages of ships is monitored at the monthly and yearly level within the selected period. Regarding the directions of import and export, the shipping agent determines the directions of the ships' voyages as inbound and outbound and provides such attributes. Inbound voyage is considered an 'import' of goods, while outbound voyage is considered an 'export', which does not have to coincide with the customs direction of the goods. In the direction of export of goods, data for the quantity of shipped containers for the departure of ships departing from the port of loading are shown. It is possible that containers are included which are not actually the export of goods in the customs sense, but can be, for example, the transport of goods within EU countries.

In the direction of import of goods, data for the quantity of unloaded containers for the voyages of ships arriving at the port of unloading are shown. It is possible that containers are included that are not actually imports of goods in the customs sense, but can constitute the transport of goods within EU countries. In this context, however, it is common to talk about the direction of imports, and it is possible, as mentioned above, to use both the terms incoming and outgoing voyage of a vessel.

The planning and organization of transport in Port of Rijeka involves multiple actors of various profiles (public administration, sea shipping companies, carriers (road, rail), insurers, freight forwarders, port terminals, etc.). The role of e-TMS software is the

integration and processing of data collected from the information systems of the transport participants, as well as distribution of information from the e-TMS system to the IT systems of other actors involved in the transport chain.

One of the major problems faced by both users as well as manufacturers of e-TMS software is the lack of uniform standards for formats and ways of exchanging messages (except between shipping companies and container terminals). Organizers of transport communicate with companies of various profiles in the process of transport planning, considering the conditions and prices of transport. That means that the organizers of transport must follow the procedures of such companies, or at best, use the software provided by these companies, if available (e.g. when booking and exchanging other data related to the transport of goods).

### **3. Benefits of improved electronic Transportation Management System in Port of Rijeka**

In Croatia, starting from end of November 2013, electronic process based on online prearrival procedures, announcement and registration of arrivals and departures of ships for all vessels calling Croatia is mandatory. The optimization of transport routes and the simplification of the entire transport process will have a long-term impact on the operations in the Port of Rijeka. Besides the positive effects on companies, it will also benefit the employees and the local community.

One of the solutions used for communication between transport organizers and shipping companies is Mediation Service Software (MSS), or an Electronic Transaction Platform (ETP). Users of electronic transaction platforms are able to communicate with a large number of global shipping companies in the standardized way. It is possible to use a software package (a web portal or an application) or to integrate own applications with the electronic transaction platform. The mediation services include: sending the obligatory data regarding the weight of goods, transport booking, sending shipping instructions, tracking the movement of containers, the exchange of bill of lading data, etc. Implementation of these functionalities is usually done using cloud-based deployment of provided services.

The basic benefit and reason for the cloud-based deployment of an e-TMS lies in storing information in a central location. This allows the provider to manage updates without disrupting user access. In turn, user access can be maintained and expanded through scalable, cloud-based solution, ensuring all users can access the system without interruption. The cloud e-TMS can be accessed from any Internet-enabled device, including mobile devices. This means that managing shipments and inventory can be simplified. Improved electronic Transportation Management System provides mainly ecological and economic benefits, which will be further analyzed.

#### *3.1. Economic benefits of e-TMS in the Port of Rijeka*

Electronic Transportation Management System will reduce shipping expenses in the Port of Rijeka since all shipping information are brought into central repository. It also enables shippers to compare carrier rates, which improves the negotiation position, since the management of the system is accomplished remotely (CTSI Global, 2019).

Cloud-based TMS are becoming strongly preferred over on-premise software since they are much more agile, easier to install, maintain, and upgrade (leading to a faster return on investment) and create an opportunity for next-level collaboration across supply chains (Kuebix, 2020). Shippers do not have to worry about storing equipment, software, and servers in their building and the computer terminals do not require updates for the TMS to function, and the ability to scale up or down operations is maintained (Cerasis, 2020). In this way, the investment and implementation costs in the Port of Rijeka may be reduced. Cloud computing itself relies on sharing data storage, computing, and security, which allows companies to receive the benefits of TMS software without some of the costs (3Gtms, 2020).

A cloud-based Transportation Management System provides numerous benefits such as: improved economy of scale, lower total cost of ownership, no upgrade fees, faster return on investment, faster deployments, fewer hours needed for training and installation, automatic updates with the latest features, and improved security (ORACLE, 2020). Therefore, cloud e-TMS solution in Port of Rijeka will enable the optimization of business processes, timely, simplified and reliable data exchange and business processes among all stakeholders, ultimately reducing overall costs.

#### *3.2. Ecological benefits of e-TMS in the Port of Rijeka*

While seaports promote the economic development, they also have a negative impact on the environment (Zheng, Zhao, & Shao, 2020). Some seaports adopt environmental management initiatives for regulatory compliance, while others go beyond compliance viewing sustainability as a key element of their operational strategy (Hossain, Adams, & Walker, 2020). Ships are also major contributors to emissions in ports, even when they are idle or berthed (Notteboom, Lugt, Saase, Sel, & Neyens, 2020).

Considering that ports are key nodes of the maritime transport network, it is of great importance to identify ships' arrivals and departures (Wu, Xu, & Wang, 2020). The e-TMS should assist in the process of reducing harmful emissions, to aim for smart operations, to share information and to have an integrated logistics chain, where the operations are safe and cost-efficient (Springer International Publishing, 2019). The Ericsson sustainability report shows that ICT could help reduce global greenhouse gas (GHG) emissions (Oyedeji, Seffah, & Penzenstadler, 2018).

Improved electronic Transportation Management System may provide ecological benefits to users in the Port of Rijeka. For example, according to the "Transporeon Group" (linking manufacturers, retailers and wholesalers with logistics service providers), an electronic Transportation Management System can help shippers handle transport capacity fluctuation and eliminate empty runs, while lowering CO<sub>2</sub> emissions by up to 10% ("TRANSPOREON Logistics Software for Transportation Management," 2019). According to (Ascencio, González-Ramírez, Bearzotti, Smith, & Camacho-Vallejo, 2014), unnecessary long waiting time is the result of the existence of a large number of public and private stakeholders that interact in transport operations which causes significant coordination problems among the port terminals and their main users, in addition requiring very large number of transactions and documentation processes, most of them based on paper documents. In the Port of Rijeka, the exchange of documents is mainly conducted in paper format, which implies longer waiting times for vessels. Timely information may cut the time ships spend idling inside and outside ports and help reduce harmful emissions. To achieve that, it is necessary to communicate in advance the relevant information to the ship about the requested time of arrival - allowing the ship to adjust to optimum speed (Port of Rotterdam, 2020).

#### 4. Conclusions

Despite numerous benefits that digitalization provides, paper-based document exchange is still present in less developed seaports. The following are common issues in such seaports: lack of integrated systems covering all business processes; certain stakeholders are not properly integrated into the transport chain, stakeholder resistance due the lack of awareness of the importance of digitalization, etc.

Port of Rijeka, an intermodal and a multi-purpose seaport, represents a less developed seaport in which the exchange of paper documents still exists. One of the disadvantages of the current electronic Transportation Management System in the Port of Rijeka is that it is not possible to provide remote user access. Furthermore, the exchange of documents in the Port of Rijeka is largely carried out in paper format, which means longer waiting times for vessels.

In order to simplify the business processes, improved, cloud-based e-TMS in Port of Rijeka is suggested, with the ability to work from remote locations and with the support for mobile devices, using cloud delivery. The e-TMS may be defined as a solution that streamlines the shipping processes and facilitates monitoring of physical or administrative operations related to transportation, planning and decision-making. Improved electronic Transportation Management System should enable users in Port of Rijeka to optimize their business processes by connecting various seaport stakeholders, providing sustainability benefits, especially ecological and economic.

Cloud based e-TMS in Port of Rijeka will allow business process optimization, timely, streamlined and efficient data sharing and business processes among all stakeholders, eventually reducing overall costs. From the ecological aspect, cloud-based e-TMS may have a positive impact on fuel consumption and the reduction of harmful emissions in seaports. Timely data delivery will minimize the time that ships spend idling within and outside ports and will help to reduce harmful emissions.

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# The role of port authority in seaport governance

Ana Panjako <sup>1</sup>, Marija Jović <sup>2</sup>, Edvard Tijan <sup>3</sup>, Alen Jugović <sup>4</sup>

<sup>1</sup> Department of management, Ca' Foscari University of Venice, Italy

<sup>2</sup> Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia

<sup>3\*</sup> Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia

<sup>4</sup> Department of maritime logistics and management, University of Rijeka, Faculty of Maritime Studies, Croatia

\*Corresponding Author: e-mail: [etijan@pfri.hr](mailto:etijan@pfri.hr)

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## Abstract

Both the governments and port authorities have a significant impact on the maritime transport sector in general, and seaports in particular. In this paper, the focus is on the port authorities and their role in seaport governance. While central governments are focused on macroeconomic goals (such as economic growth and full employment) through active port policies, port authorities usually focus on financial and operational activities within the seaports. Although the common form is a local port authority, port authorities may also be established at the national, regional and provincial level. One of the core responsibilities of a port authority is to develop and maintain a seaport that is safe, sustainable and competitive. The roles of port authorities have evolved over time: at the beginning, they were usually considered only as regulators and landlords. However, port authorities possess the ability to evolve into real digital hubs and neutral data managers, which ultimately leads to the optimization of logistics processes, and more efficient use of transport infrastructure. In this paper, the theoretical frameworks of seaports, seaport governance and port authorities were provided. The authors have analyzed the differences between various types of port authorities and seaport governance models, emphasizing the importance of port authorities in port governance.

*Keywords:* Seaports, port authorities, seaport governance, governance models.

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## 1. Introduction

Seaports are a way of entry into the global economic system (G. S. Dwarakish & Salim, 2015), and play an important role in the trade development and in the global economy. Seaports affect the economic and social development of the countries (Hlali & Hammami, 2017); in other words, seaports have a significant impact locally, regionally and nationally ("Seaport Advantages," n.d.).

Port governance is a complex issue that is inseparable from different stages in history, cultures and geography, and from the different forms of political, economic and administrative organization prevailing in each, in different spatial and temporal combinations (Cepal, 2015). In recent decades, extensive seaport reforms have challenged the conventional models of seaport organization (Brooks & Pallis, 2008). At the very beginning, changes in governance models could be related to market changes, the establishment of new goals, etc., however, over the time, reasons that lead governance reforms are changing (for example, traditional ports facing physical restrictions that require the construction of new facilities) (Laxe, Sánchez, & Garcia-Alonso, 2016). In the past three decades, port governance has received a great deal of attention from academics, port authorities including policy and decision-makers in the maritime sector, and port governance itself has increasingly become an important academic and functional principle in the port sector. (Zhang, Zheng, Geerlings, & Makhouloufi, 2019).

Traditionally, port authorities have been responsible for the growth, management and infrastructure of the port area (L. M. van der Lugt, 2015). Port authorities pursue multiple objectives that contribute to the general interest of the society such as: facilitating trade and business, ensuring that port activity is sustainable in the long run, developing maritime and hinterland connectivity, etc. (ESPO project, 2016). Regardless of the ownership and the managerial tradition to which they belong, port authorities are entities of a hybrid nature which contain elements of both public and private law (Verhoeven, 2010). Port authorities tend to be vertically integrated entities as they are involved in most of the activities related to port operations, from the construction and maintenance of infrastructure to the marketing and management of port services (Rodrigue & Notteboom, n.d.).

In this paper the importance is given to the port authority's role as a port governing body. Its significant impact on governing and managing port facilities and ports as a whole is analyzed. The paper consists of five parts. The Introduction provides better understanding of the topic, the research goal and the paper's structure. The terminology of seaports, port governance and port authorities are given in the second part. Diverse port government models are presented in the third part of the paper. The focus on port authorities as a governmental body is given in the fourth part. The final part, Conclusion, presents the synthesis of the research.

## 2. Seaports, seaport governance and port authorities

Seaports, defined as a geographical location where cargo changes transport mode, one of these being a seagoing vessel, are important drivers of the regional economy of which they are part (Hintjens, Hassel, Vanelslander, & Voorde, 2020). Seaports may also be defined as economic units providing a service or nodes between various transportation modes, or as facilities through which cargo pass, or as a part of logistics and supply chain (Woo, Pettit, Kwak, & Beresford, 2011). Modern seaports cannot be treated as a single unit because of their complexity. In this respect, seaport, as an important part of transportation system, involves numerous stakeholders such as port authorities, shipping companies, freight brokers, etc. which have to closely cooperate (Tijan, Jović, & Karanikić, 2019).

Governance is the adoption and enforcement of rules governing conduct and property rights. The scope of governance change is to adjust strategies and corporate goals in order to align with the contextual economic environment (Brooks & Pallis, 2011). Many governments are to some extent responsible for port development and often use a 'growth pole' argument in order to justify the direct financing of basic port infrastructure. This growth pole rationale derives from the belief that investments in port assets multiply affect the entire national economy and that the commitment of public resources is necessary to encourage co-investment by the commercial and industrial sectors (PPIAF, n.d.-a). On the other hand, port operations are businesses in their own right and should be managed to achieve optimal utilization of capital. Investments in port assets are influenced by risk, competition for land and capital, or other factors (PPIAF, n.d.-a). Subsidies and government-provided incentives distort the allocation of resources for port development and may result in over- or underinvestment. (...) Port authority (also known as port management or port administration) is generally a governing body in the port (PPIAF, n.d.-a).

“Port authority” or “port managing body” is an entity which, regardless of ownership and other institutional features, assumes public, commercial and economic responsibilities. This hybrid character makes port authorities ideally placed to meet the various challenges that both market forces and society impose upon seaports (European Sea Ports Organisation, 2019). The port authority is defined in the Cambridge dictionary as “the official organization that controls and manages the activities in a port” (Cambridge Dictionary, n.d.). Van der Lugt and De Langen (Port authority strategy: Beyond the landlord a conceptual approach, 2018.) define the port authority as a “land manager with responsibility for a safe, sustainable and competitive development of the port.” (L. van der Lugt & Langen, 2018). In 1977, a commission of the European Union defined a port authority as a “State, Municipal, public, or private body, which is largely responsible for the tasks of construction, administration and sometimes the operation of port facilities and, in certain circumstances, for security” (PPIAF, n.d.-a). „In most countries, the port authority is a public or semi-public organization responsible for the management and development of the port area by constructing and maintaining infrastructure, providing this infrastructure to private companies through leases or concessions, and ensuring the development and competitiveness of the port cluster. Most port authorities operate broadly speaking according to the ‘landlord’ model.” (Dooms, Lugt, & Langen, 2013).

## 3. Seaport governance models

“Decisions about the port governance model can be made by several stakeholders under the influence of external environmental factors. The complexity and diversity of models does not allow us to analyze the totality of the characteristics of each one. But it is possible to find variables that allow to differentiate tendencies in port reform processes and the application of classic models in diverse regions of the world. One of the main variables of port governance is associated to the type of port authority, its main functions and relationship with port operators” (Caldeirinha, Felício, Cunha, & Luz, 2018).

“The World Bank (2001) identified four models of port governance: the public service port, the private port, the tool port (a mixed model where private sector operators perform some of the operations but under the direction of public sector managers) and the landlord port (the public sector retains ownership while the terminal management and operations are leased to private sector operators)” (Monios, 2019). Port infrastructure and superstructure as well as cargo handling equipment is owned and developed by the port authority within the tool port model. Port authority staff usually operates all equipment owned by the port authority (PPIAF, n.d.-a). “The most common and dominant model of port governance to emerge in the early twenty-first century has undoubtedly been the landlord port model, whereby a public port authority acts as both landlord and regulatory body, while private companies carry out port operations. The landlord model has a number of variants, depending upon the level of decentralization and autonomy of the port authority involved, the cultural disposition of the country considered or the level of involvement of the landlord in furthering and enhancing port activities” (Brooks, Cullinane, & Pallis, 2017). Acting as landlords, port authorities are managing bodies in charge of the port land and infrastructure as well as its development. (European Sea Ports Organisation, 2019). Regarding the strategic significance of land, port property is rarely sold outright to private parties because of its direct and indirect effects on regional and often national economy and public welfare, its intrinsic value, and possible scarcity (PPIAF, n.d.-a). Therefore, the key role of many port authorities is that of the landlord, which means that they are responsible for the management of real estate within the port area (including the economic exploitation, the long-term development, etc.) (PPIAF, n.d.-a).

“Port government decisions are related to maximization of impact on performance and the performance of the economy. Positive or balanced financial results are common goals in many countries when deciding on governance models. The

effectiveness, the customer satisfaction and supply chains are important objectives, but little considered in port governance decisions” (Caldeirinha et al., 2018). Academic research has followed field developments while the search for a perfect model has led to the continuation of reform activities by governments. The World Bank has developed World Bank Port Reform Tool Kit for state development, which is focused on the role (landlord, tool, service or private) and activities of port authorities as a core theme of port governance but does not provide any evidence as to what governance models result in better performance outcomes or how ports themselves may respond to a government - imposed governance reform (Brooks & Pallis, 2011).

#### 4. Importance of port authority in seaport governance

In a comprehensive analysis of the port industry ‘Port Economics, Management and Policy’ (2020), it is stated that the close cooperation between the responsible government department (such as ministry or other relevant policy-actors) and the port authority (which is responsible for the management and operation of the port), is important for the successful governance of a port and/or a port system (Notteboom, Pallis, & Rodrigue, 2020). Under the regulator function, port authorities ensure the application and enforcement of rules and regulations set by local, regional, national or other agencies. The power balance with government stands out as a principal factor which influences the legal and statutory framework, the financial capability and the room for a pro-active management culture at the corporate level of the port authority (Verhoeven, 2010).

Port authorities may be established at all levels of government: national, regional, provincial, or local. The last one is the most common form, which means that it administrates only one port area (PPIAF, n.d.-a). According to (Brooks et al., 2017), most port authorities have retained at least control over, if not ownership of, port infrastructure, irrespective of whether the port authority in question is nationally (e.g. Cyprus), regionally (e.g. Belgium and the Netherlands) or port-based (e.g. Korea). The case of Taiwan provides one exception to this in that most port operations remain state-run in the hands of the port authority (Brooks et al., 2017).

Port authorities at local levels are holding key positions in port governance configurations through their power position and interactions they are holding with landlord, regulatory, and community manager functions. There are some exceptions to this observation in the case, for example, of some counties where the governments begin to exert more influences, or in the extreme case of the UK where assets and regulatory functions have been devolved to the private sector (Zhang, Geerlings, Makhloufi, & Chen, 2018).

Ship and port dues and charges and income from real estate, whatsoever their nature, arising in the port domain, are earned and destined for the port authority, with exclusion of all other authorities (PPIAF, n.d.-b). The tariffs are determined by the port authority. The proceeds of the tariffs shall be sufficient to meet the financial needs of the port, including operational expenses, the maintenance of assets, the payment of interest, allocation for depreciation of assets, and other standard commercial elements (including shareholders' dividends and a reasonable profit). The port authority can take loans and issue bonds and securities (PPIAF, n.d.-b).

Reform of port governance via concessions is a trend that has been accelerated by the advent of containerization and the development of container terminals (Brooks & Pallis, 2011). Cargo handling services are generally in the hands of private operators who are generally granted the use of port land through lease agreements or public domain concessions (European Sea Ports Organisation, 2019). According to (Brooks & Pallis, 2011), the port authorities grant private terminal - operating companies concessions to operate a terminal, and receive a concession fee. The responsibility for investment differs between concessions: in some cases, the public PA invests in quays and terminal area, while in other cases the private terminal operator has to make these investments. Port authorities can spend enormous amounts of money on marketing but, if terminal operators or shipping lines do not perform well, the actions will not have the aimed effect. For this reason, the selection of reliable terminal operators as concessionaires constitutes a relevant pre-condition for attracting demand (Parola, A.Pallis, Risitano, & Ferretti, 2018). (Parola et al., 2018) also claim that port authorities are tempted to catch-up other business opportunities in areas that go beyond their core objectives, e.g. ship-repairing or hotel management (e.g., the new master plan of Piraeus).

Sustainability issues have become a vital element of maritime logistics; these include greening of ports, zero carbon shipping and reducing emissions from vessels, etc. (Shin et al., 2018). This has resulted in stronger environmental regulations and local community concerns that pressure the port authority to develop green port policies and create additional costs for terminal operators, such as replacing port equipment powered by clean energy (Senarak, 2020). In 2014, PIANC (the World Association for Waterborne Transport Infrastructure) published a Guideline for Port Authorities “Sustainable Ports” which aims to increase the awareness about sustainability issues in ports (such as land use planning, modalities and connectivity, air quality, etc.) and help the port authorities to better face the challenge of becoming sustainable ports with many practical solutions (PIANC (World Association for Waterborne Transport Infrastructure), 2014). For example, the Port of Rotterdam Authority is aware of the importance of the sustainable business and therefore aims to enhance the port’s competitive position as a logistics hub, but at the same time leads to the transition to sustainable energy and encourages digitalization of business processes in order to make the port, and the supply chain, more efficient (Port of Rotterdam Authority, 2020). In 2012, the Port Authority of Barcelona joined the voluntary agreements to reduce GHG emissions promoted by the Catalan Climate Change Office and committed to gradually reduce (in its seaport) the direct and indirect emissions caused by the fuel consumption of its fleet of 120 vehicles, two boats and certain generators, as well as to reduce its electrical consumption (Azarkamand, Wooldridge, & Darbra, 2020).

The port authorities, such as government or local authority, are continually checking the performance of the terminals in which they have invested, and want to reflect it in the development policy and to increase competitiveness by checking performance levels (such as port handling volume, calling ships, resource utilization, and congestion) (Park & Lee, 2020). Furthermore, as supply chains become more integrated, hinterland operations become more pronounced. Port authorities can start up strategy relations with other transport nodes in the hinterland, which are usually aimed at: traffic management, land management, hinterland connections, etc. (Donselaar, 2010). Port authorities should focus on improving hinterland connections by taking the lead in drawing up a joint investment program for the necessary infrastructure improvements; adding that a port authority can facilitate the application of technology and enable better insight into traffic flows, helping enterprises to further optimize their supply chains and make them more flexible (Jović, Kavran, Aksentijević, & Tijan, 2019). Consequently, it will increase the attractiveness of the ports as a result of the lower hinterland connection costs (Hintjens et al., 2020).

Port authorities can develop into real digital hubs and neutral data managers at the service of the transport and logistic chain. By gathering and exchanging real-time information among different parties in the process, logistics processes can be optimized, and transport infrastructure can be used in a more efficient way (European Sea Ports Organisation, 2019). In order to strengthen the position of seaports and improve their business, some port authorities closely cooperate. The American Association of Port Authorities (AAPA) is a trade association that represents deep draft public port authorities throughout the U.S., Canada, Latin America and the Caribbean (AAPA, n.d.-b). For more than a century, AAPA membership has empowered port authorities and their maritime industry partners to serve global customers and create economic and social value for their communities (AAPA, n.d.-a). Another example is Croatian Association of Port Authorities. The development and shaping of this Association is one of the important issues of national interest and enables the creation of the economic and legal bases for the development of the national port system and of individual ports within that system (Port Authority, n.d.).

## 5. Conclusions

A significant contribution to the global economy is made by seaports. They play a key role and act as an incentive for the growth of the marine economy, particularly for the national economies and involves a large number of stakeholders. Many governments are somehow accountable for port development which is reflected mostly through the port control and implementation of the rules governing conduct and property rights as well as investments in the port estate.

The port authority is the main body in almost any port, responsible for governing and developing the port or a port system. As a public body it plays a significant role in governing the port. Acting as landlord, the port authority is responsible for managing the real estate within the port area. The port authority handles income from real estate and issues financial needs of the port such as ship and port dues and charges. It is also responsible for handling hinterland connections and developing the port area, depending on diverse external environmental port factors. There are different port governance models related to the type of port authority, level of centralization and autonomy, its principal functions and the relation with port operators. Maximization of impact on performance and financial results are considered when deciding on governance models. There is no provided evidence on which governance model results in better performance outcomes, as it is specific for every port related to many beforementioned factors.

In this particular paper the main goal was to analyze the importance of a port authority as the main port governmental body. Based on the findings in this paper, the authors were able to prove that a close relation between the responsible government department and the port authority is of the main importance for the successful port governance. Port authorities have vast regulatory powers for applying regulations, laws and rules. The important factor for port authorities is power balance with governments which have a substantial impact on a financial strength as well as on the legal and statutory framework. More recently, emphasis has been placed on sustainable port development, increasing the awareness about sustainability issues in ports affecting port authorities to develop green port policies and make some radical changes in the process of becoming sustainable ports. Furthermore, the importance of port authorities lays in optimization of logistics processes through gathering and exchanging real-time information between stakeholders by transforming port authorities into actual digital hubs. Numerous associations of port authorities exist, established in order to empower port authorities and to strengthen their position.

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# Intensive care unit nurse's workload and quantitative determination of patient care classes

Diana Platace<sup>1</sup>, Svetlana Kulesova<sup>2</sup>

<sup>1,2</sup>Department of Nursing and Midwifery, Faculty of Public Health and Social Welfare, Rīga Stradiņš University, Latvia  
Corresponding Author e-mail: diana.platace@rsu.lv

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## Abstract

**Introduction.** Nurses' contribution is an important determinant of clinical recovery outcome. Health care quality improvement requires instruments for adequate evaluation of patients' clinical conditions and corresponding estimated health care. Therapeutic intervention scoring system provides evaluation of nurse's workload, estimation of patient related activity relative to the total working time, clinical condition severity etc. Evaluation of workload and required intervention amount attempts to forecast scope of necessary time and competence resources required for improvement of patient safety and care quality improvement, providing basis for adequate health care personnel allocation in hospitals. The aim is estimation of intensive care unit nurse's workload and quantitative determination of patient care classes.

**Study methods:** quantitative (TISS-76 scale). Research participants - nurses of intensive care units (n=539). Results of the study showed that increasing proportion of therapeutic intervention measured by TISS score, implies direct correlation between clinical condition severity and amount of therapeutic interventions.

**Results.** Using the TISS-76 scale, certain classes of patient care were defined. The highest number of patients in care class III was 297 or 55%, for whom the average number of manipulations during the day was 25. The number of patients in care class II was 235 or 44%. The lowest number of patients in care class IV was 7 or 1%. The nursing/patient ratio during the study was on average 1: 2.8 - almost three times higher than the recommended norm for patients with care classes IV and III. There was a considerable variety of care activities and a variety of manipulations in the intensive care unit's nurses. The average maximum number of TISS points was 2 times higher than the average minimum number of TISS points.

**Keywords:** intensive care unit, nurse, critically ill patients, workload, therapeutic intervention classes, TISS.

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## Introduction

Each year, many patients are hospitalized in an intensive care units (ICUs). This, in turn, leads to a larger number of complex procedures requiring more supervision and the need for nurse work intervention, thereby increasing nurse's workload and higher costs (Sprung *et al.*, 2012). There is a significant increase in the need for methods and means to monitor the quality of intensive care work and to assess the workload of nurses. Improving health care requires tools to assess patients' clinical status and needed care. Many aspects of the ICU, such as nurse activity and therapeutic intervention intensities, which are indirect measures of the ICU process, cannot be assessed using physiological evaluation systems, therefore, TISS is used (Hariharan *et al.*, 2007). TISS (Therapeutic intervention scoring system) can use to assess the workload of nurses, analyze the patient's duration as a percentage of the total time, and the severity of the patient's disease etc. (Perão *et al.*, 2014). The assessment of workload and size is an attempt to anticipate the time and skills needed to improve the quality of care and patient safety, and to allow authorities to allocate adequate staffing to intensive care units. The severity of patients (health status) is an instrument to be used to demonstrate the instability of these patients and the probability of health recovery. There are patient classification systems where the assessment of different variables can contribute to the provision of care (Perão *et al.*, 2014). Based on the ratio of the number of nurses to the ICU patients, the level of care is divided into three categories: class III – the highest (nurses-to-patients ratio is 1: 1), class II (nurses-to-patients ratio is 1: 1.6 or 1: 2) and class I is the lowest (nurses-to-patients ratio is 1: 3). (Vanags *et al.*, 2008). It is important to allocate the workload optimally so that human resources can be used correctly and effectively, which can improve the patient care of ICU. Several international studies reflect that the workload of nurses is one of the most important indicators to assess the safety and quality of care in an intensive care units. The study aim is to determine intensive care unit nurse's workload and patient care classes.

## Methods

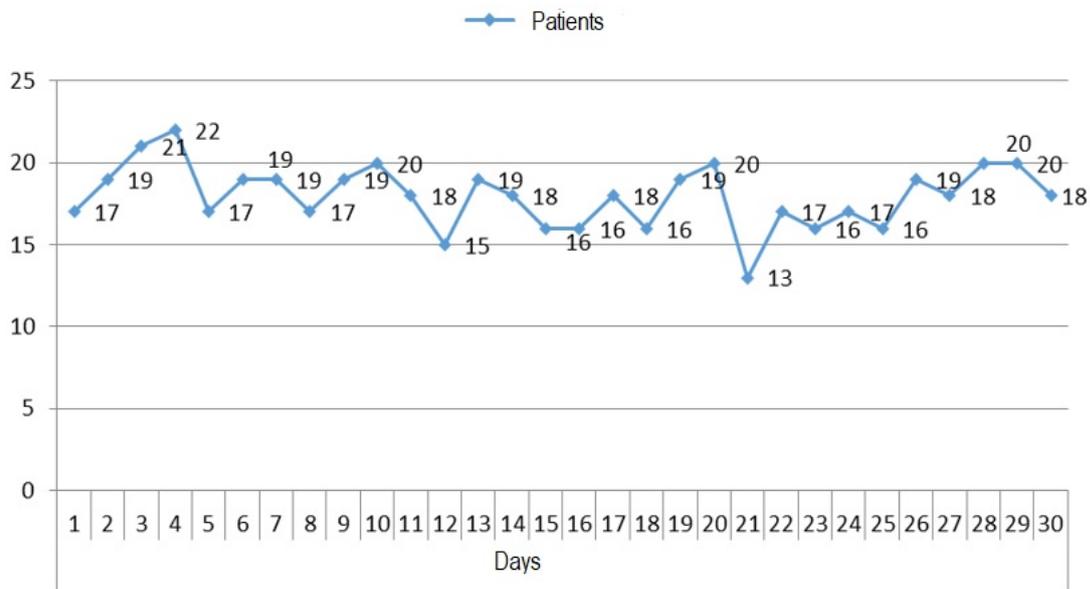
A quantitative study method was used in the study. The TISS-76 scale (Therapeutic intervention scoring system) has been selected as a study tool, consisting of 76 nurse manipulation (care measures). 76 standardized variables have been evaluated at a therapeutic intensity of 1 to 4, with the highest treatment rate of 4 points. The study involved all nurses in the

intensive treatment department who filled the TISS-76 (Therapeutic intervention scoring system) scale every day during 1 month (30 calendar days). Intensive care units nurses each day (once a day, always in the same period) filled TISS protocol for each patient being cared for. The study included ICU patients who admitted in the department for more than 24 hours, a total of 539 TISS protocols were collected and certain patient-care classes were determined.

Interpretation of the results: the score from 10 to 19 corresponds to the Class II (physiologically stable patient but require intensive care and continuous monitoring); the score from 20 to 39 points corresponds to Class III (severely ill patients, haemodynamically unstable); the score from 40 and more corresponds to Class IV (patient needs continuous and special care). The score of up to 10 corresponds to the care class I (no intensive care is required) (Александрович и соавт., 2010).

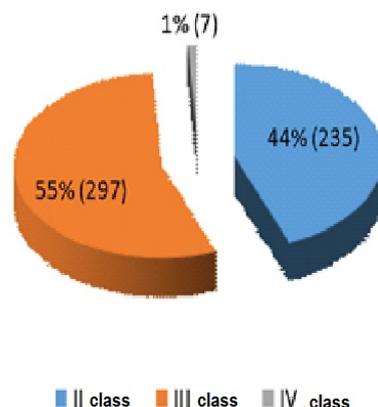
## Results

During the study, the number of patients in the ICU ranged from 13-minimum to 22maximum and averaged 17.97 (see Figure 1). The maximum number of beds in the ICU was 23. The number of nurses in the ICU remained unchanged - 8.



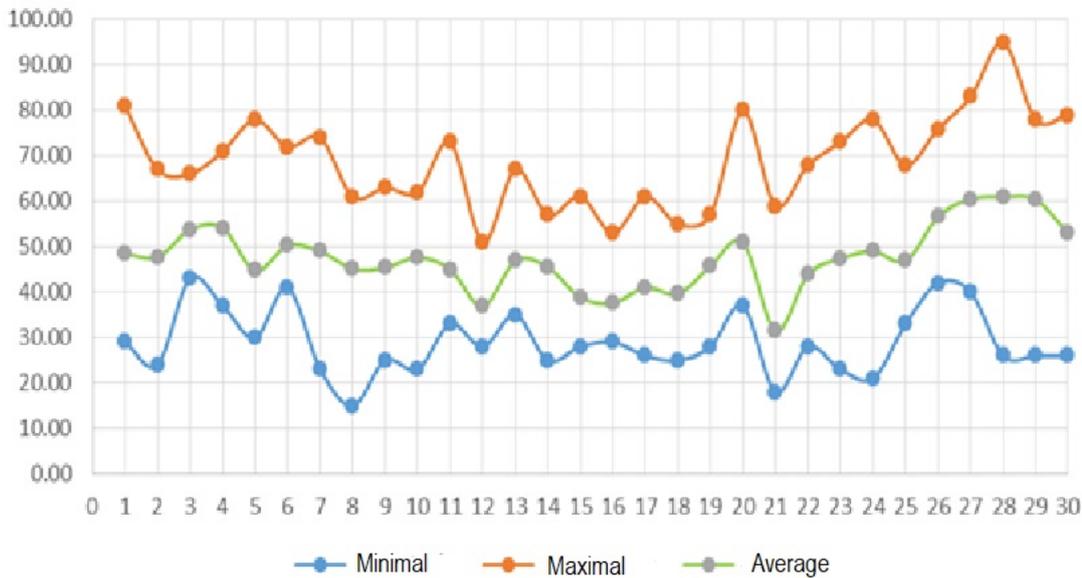
**Figure 1.** Number of patients per month receiving treatment in an intensive care unit (n=539)

TISS-76 data showed (see Figure 2) that ICU patients was predominantly severely ill, haemodynamically unstable, included in Class III (55% or n = 297). As many patients were in Class II (44%, or n = 235) – physiologically stable patients, although they needed continuous intensive care and monitoring. Less frequently, patients with a mandatory indication of continuous and specialised medical care were included in the section – class IV (1%, or n = 7).



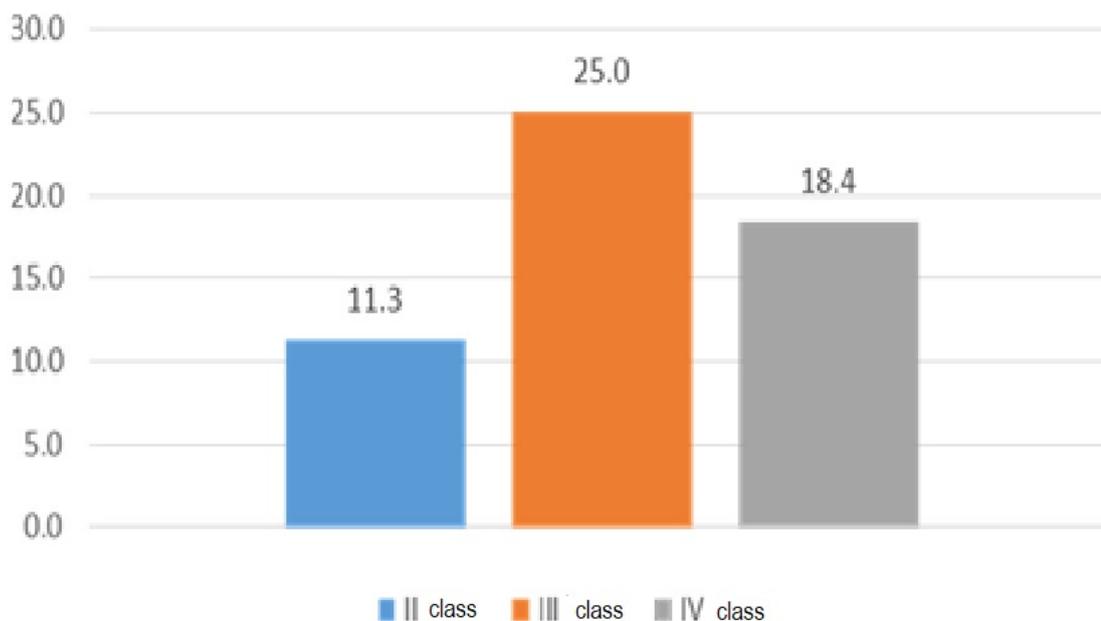
**Figure 2.** Total number of patients by severity class (n=539)

Study results showed (see Figure 3) that the difference between the minimum and the maximum numbers of TISS for nurses during the day was significant. For some nurses the work intensity was lower (15 TISS points) than recommended (46 TISS points), but for others nurses - significantly higher (95 TISS points) than recommended.



**Figure 3.** Minimum and maximum TISS points per nurse during the 24 hours

TISS-76 data showed (see Figure 4) that the average number of manipulation in Class II was 11.3 (minimum number of 10,1, maximum number of 13,0), the average number of manipulation in Class III was 25,0 in Class III (minimum number of 22,7, maximum number of 28.1), and 18.4 in Class IV (minimum number of 17,0, maximum number of 20.0).



**Figure 4.** Average number of manipulations per patient in 24 hours

The 10 most common manipulations in class II:

- ECG monitoring - 100%
- Assessment of vital functions (hourly) - 100%
- Fluid balance assessment (every 24 hours) - 99%

- Blood tests - 97%
- Bladder catheter - 94%
- Oxygen inhalation - 73%
- Regular administration of intravenous drugs - 71%
- Replacement of fluid deficit - 68%
- One PVC (peripheral venous catheter) - 66%
- *Decubitus* prevention - 52%.

The 10 most common manipulations in care class III:

- ECG monitoring - 100%
- Assessment of vital functions (hourly) - 100%
- Bladder catheter - 99%
- Fluid balance evaluation - 98%
- Blood tests-97%
- *Decubitus* prevention - 86%
- Replacement of fluid deficit - 74%
- Medication intake CV- 59%
- Suction of secretion from the trachea - 54%
- GI feeding through the probe - 53%

The 10 most common manipulations in care class IV:

- ECG monitoring - 100%
- Assessment of vital functions (hourly) - 100%
- Fluid balance evaluation - 100%
- Blood tests-100%
- *Decubitus* prevention - 100%
- Bladder catheter - 100%
- Replacement of fluid deficit - 100%
- Medication administration CV- 100%
- Suction of secretion from the trachea - 100%
- Artificial ventilation with or without PEEP- 100%

## Discussion

The ratio of nurses-to-patients was on average 1: 2.8 during the study, including 1: 2.13 minimum and 1: 2.88 maximum. For patients care of classes IV and III the ratio of nurses-to-patients was 1: 1, but patients care of Class II the a ratio of nurses-to-patients was 1: 2. It can be concluded that the actual ratio of nurses-to-patients was significantly above the recommended norms. Several studies confirm that adequate levels of nursing can improve patient care and survival opportunities. The guidelines of Australia's College of Critical Care require at least a ratio of 1: 1 for ventilated and other critically ill patients and 1: 2 for patients with single-organ failure (clinically determined). Patients requiring complex management may need higher rates (Minimum standards for intensive care units, 2011). It was found that adding an additional patient to one nurse (e.g., two patients per nurse) increased the risk of death by 7% in 30 days after admission (Guo, 2015). 40% of nurses working in hospitals have been reported to exceed the norms of healthcare workers. Significant impacts on patient safety and care arise as soon as the unbalanced relationship between patients and nurses is demonstrated due to increased workload, employee turnover and other aspects related to healthcare workers (Sousa *et al.*, 2015). Increased nurse work intensity contribute to reducing the quality of patient care and exposing ICU nurses to emotional stress that is also dangerous for patients (Aiken *et al.*, 2002). Studies have also found high levels of burn-out syndrome among ICU nurses (Tamayo *et al.*, 2010). In addition, reduced numbers of nurses in hospitals have been shown to lead to higher mortality in patients following joint operations. Studies in Belgium found that mortality following cardiac surgery was significantly lower in hospitals with a higher number of medical workers relative to the number of patients (Van den Heede *et al.*, 2009). Similarly, data from studies in Switzerland and North America showed significantly increased surgical mortality associated with insufficient numbers of care workers (Schubert *et al.*, 2012).

Research shows that in order to improve the quality of care and the cost-effectiveness ratio, the ICU is becoming increasingly needed for workload indicators (Santos *et al.*, 2012). As part of the study, the monthly average, minimum and maximum TISS points per nurse during the day was calculated: a minimum of 28.9 points, a maximum of 68.9 points and an average of 47.5 points. According to recommended standards, the nurse must be able to manage 46 TISS points per shift (Hariharan *et al.*, 2007). Consequently, the average number of TISS is almost similar to the internationally accepted standard, but the maximum average is well above, indicating the overload of nurses.

## Conclusions

The study suggests that the highest number of patients was in care class III (297 or 55%), for whom the average number of manipulations during the day was 25. The number of patients in care class II was 235 or 44%. The lowest number of patients was in care class IV (7 or 1%). The nursing/patient ratio during the study was on average 1: 2.8 - almost three times higher than the recommended norm for patients with care classes IV and III. There was a considerable variety of care activities and a variety of manipulations in the intensive care units for nurses. The average maximum number of TISS points was 2 times higher than the average minimum number of TISS points.

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