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Analysis Research on Preparation of 4th Wave (AI) of the Visegrad Group*

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Abstract

The paper suggests making a policy and strategies for a way of exporting Korean ICT product effectively in the EU and Eastern area, and an effective preparation of 4th industrial revolution through analysis of preparation status of 4th industrial revolution of the Visegrad group. Analyze policy, status, what they want for 4th preparation in the Visegrad group from comparing characteristics analysis of each country's official data, publication data, portal, paper, and etc. They have been preparing for 4th industrial revolution long time ago as basic research and business before 4th wave word. With these basic results, they are trying to apply such as, AI, S/W, security, ICT, etc. of 4th wave core technology. For the development of new export market in EU, the Korean team should research with university and research center or venture company. Through these cooperation, they should understand their personal characteristic, lifestyle, and what consumers want to purchase in EU. And this results can be used in South Asia and India that give a big effect to all over the world ICT market. The external impact of the 4th wave must have a long-term shift in manpower, and production policy is related to the EU's strategic role, or the preparation of the 4th wave to the V4 country in the short term.

Keywords: Visegrad, Market-Development, ICT, 4th wave, AI.

JEL Classification Code: O33, O34, R11, R1.

1. Introduction

The Visegrad Group (V4) that composed of Czech, Poland, Hungary, Slovakia has been developing economically and it has been growing as 4th export and import group of Korea (Ministry of Foreigner affairs of Republic of Poland, 2018).

As average growth rate of countries of the Visegrad is 2.6% at 1995 and is 3.5% at 2012, it is over 1.9% of EU average (Hyundai economy-VIP report (2013)). Therefore, the importance of this group is increasing.

That is, when the economic average growth of EU-28 countries is 100, Poland from 43 (1995) to 68 (2013), the CZ is from 77 to 80, the Slovakia is from 48 to 76, and the

Hungary from 52 to 67. As the GDP growth of the V4 is from 3,305 (1995) to 11,895 (2013), it has been increased with about 3.6 time (KIEP, 2014).

The V4 is a very stable politically group and they have the high educated manpower, which's salary is lower than those of Western EU. The V4 has been supporting ODA (Official Development Assistance) from 2013.

Therefore, it is necessary for Korea to cooperate for investment, export, co-research, and others, through information sharing among ODA country. As the selection rate of EU R&D of Poland is 20% it is a very high competition to other countries.

So, through co-research, building human networking, making infrastructure and strategy for export, and Korea should prepare 4th wave through co-research and partnership. The Korea government has been supporting EU R&D but it is not easy because of many reasons.

As the V4's has a strong education system it is a very useful when Korea is going to build an infrastructure. Because there are several Korean company such as, Samsung and Hankook tire of Hungary, KIA auto company in Slovakia, and etc., they are having friendship to Korean.

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Scientifically, as the Hungary has 13 Nobel prizes, the Poland has 12 Nobel prizes, the CZ has 5 Nobel prizes, the Romania has 3 Nobel prizes, their basic research capabilities are stronger than that of Korea.

The EU has an enough culture and various heritages through a long history and has a capability to develop good content based on culture and experience. It means that they can development the key technology of the 4th wave because 4th industry revolution is based on knowledge and creation through manpower and good experience. The competition of 4th wave depends on manpower. That is, it can be decided by how many creative manpower they have. The EU can have initiative again if 4th wave is coming up.

This paper analyzes the status of 4th wave preparation of the V4 country and suggests the export innovation strategy. The main purpose of this paper is going to provide an idea for implementation strategy of 4th wave and export or cooperation with the V4 through analysis of status of 4th wave in the V4.

The artificial intelligence (AI) among 4th wave is core technology. So, status and application of AI for 4th wave in these countries be analyzed to provide for export activity and to use for 4th wave preparation of Korean.

2. Analysis Model about Status of 4th wave in the V4

2. 1. The Geological importance

As the V4 is located in the middle of the EU, it can have the role of bridge between Eastern European region and Western region. This geological advantage can provide for investment and human exchange.

This geological advance also provides the strong role of trade and connection as well as hub for product. Many

Countries of the EU have been using gas from Russia. Therefore, the V4 has the role of energy linking line. The V4 group also has many similarities in culture politically, economically and they are getting 30% of the EU fund by the strong connection.

2.2. Preparation status of 4th wave of the EU and Policy

As the V4 is one part of the EU, their policy is strongly linked with the EU policy. So, status of 4th wave preparation in the EU should be analyzed to know status of 4th wave in the V4.

The EU committee published report 'Reskilling for the Fourth Industrial Revolution, Formulating a European Strategy' on Nov. 3, 2016 (Paul, 2016).

In this report, they have a first question "Why is the digital transformation important?" It means that the EU thinks the serious situation for 4th wave and preparing using example of IT Company of the United States such as Google, Amazon, Apple, MS, and etc. They are expecting that all physical device and facilities should be connected and information sharing will be done. These technologies are AI, cloud computing, sensor, and big data. Juniper Research is expecting 3,805mil devices will be connected till 2020.

The EU committee expects that the traditional product system will be changed to smart manufacturing by IoT, AI, and network. And they have a solution that the core technology of this product systems are AI and platform.

The EU committee worries about the turnover of four ICT company such as, Google, Amazon, Apple, and MS is greater than the GDP of Italy in 2015. The EU committee have a conclusion that this reason is due to the ICT technology.

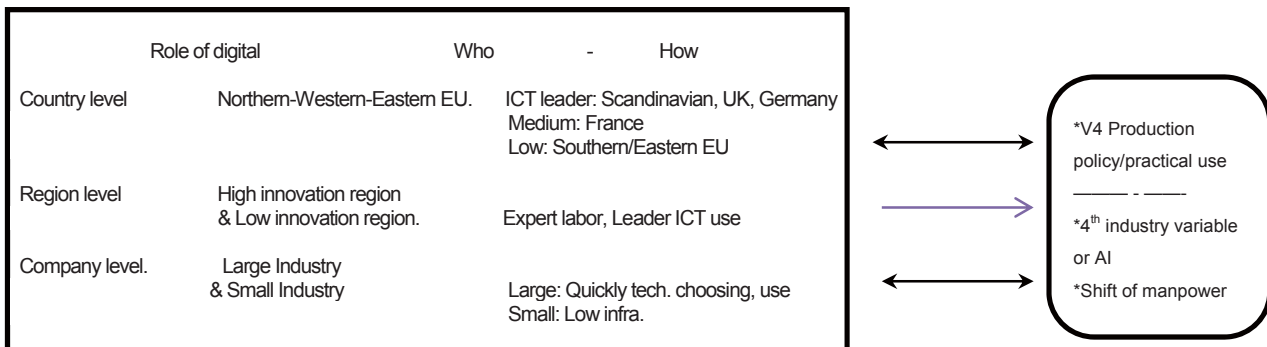


Figure 1: The proposed 4th wave conception of V4 role.

The EU committee (2016) decided building and supporting of 'Digitalizing European Industry'. This key target is to support when one SMC (Small and Medium Company) makes an infrastructure for product system. This project has been operating in the name of 'Digital Single Market strategy (DSM)'.

The index of the EU by making with venture's size, capital risk for digital industry, the number of expert (%) in ICT company by using material of 'World Economic Forum'.

The CZ and Poland almost 46 shows and Hungary about 38, Slovakia shows index 75, they have a lower index comparing to EU country such as, Finland or Germany.

The companies of Korea can use these materials and information effectively for cooperation when they want to build partnership for cooperation or expert.

Depends on country, the preparations level for 4th wave is different. Therefore, the EU committee has the strategy with region initiative, country initiative, and EU initiative as shown in Table 1. (This table is reorganized by using Kevin Hernasdez, 2016).

The status of R&D of the EU represents. We can see their R&D activity has a strong and industrial portion is bigger those of universities or governments from Ref. (Paul, 2016). It means that they have a focus on innovation of industry and product, and practical area to enhance their infrastructure of 4th wave. Therefore, we have to consider their strategy and policy, and for cooperation and export.

2.3. Hypotheses

Based on the above data, it is highly probable that the 4th industry variables and V4 are related to the EU's R&D, and this study shows that the 4th wave is a combination of industrial production and strategy, export, Infrastructure, and local specialization. The following hypothesis is conceivable.

Hypothesis 1: This is the relationship between the strategic development of V4 and the balance of the 4th industry variable.

Hypothesis 2: The preparation of the 4th Industrial Revolution is related to the V4 countries in the short term.

Hypothesis 3: Production policy is related to the EU strategy role in the short term.

Hypothesis 4: The impact from the outside of the 4th wave is related to the change of manpower in the long term.

3. 4th wave and AI of the V4

3.1. The CZ's 4th wave preparation and analysis

The industrial status of the CZ: The GDP of the CZ is 18,266.55USD over Poland (12,372.42) and Slovakia (16,495.99). The CZ has been developing heavy industry (CZ has 70% of industry during while Hungary-Austrian empire). Therefore, they have many R&D infra.

The CZ's economic status is organized by manufacturing (35%) and service among them is 62.3% and agriculture is 2.8%. Major structure of manufacturing is mechanical area, engineering, mining, chemical, food industry (CZ economic fact, 2018).

The CZ's engineering is important industry as export. Auto related industry was 54.2% of export and employee is 120,000. Big and important companies as auto company are Škoda Auto, Tatra Kopřivnice, Aero Vodochody, and České loděnice Děčín.

Table 1: Visegrad country 4th-Revolution

Country	Population	GDP (world bank 2018)	4th-Revolution
CZ	1056	18,266.55	AI service
PL	3795	12,372.42	AI ICT
HU	981.8	12,664.80	AI R&D
SK	542.9	16,495.99	AI Auto

Table 2: CZ industry

Area	Year	rate	09	10	11	12	13	14	15	16
Agri/Fish			1.8	1.7	2.4	2.6	2.7	2.7	2.5	2.5
Industry (including energy)		%	30.0	29.9	30.8	31.0	31.0	32.4	32.2	32.1
Architecture		%	6.7	6.9	6.2	5.9	5.7	5.5	5.6	5.5
trade/transportation/hotel/service		%	18.2	18.6	18.2	18.3	18.0	17.8	18.5	18.6
ICT		%	5.3	5.1	5.2	5.1	5.0	5.0	5.1	5.1
Finance/insurance		%	4.5	4.7	4.6	4.5	4.7	4.3	4.3	4.2
Invest		%	9.0	9.0	8.8	8.8	8.8	8.6	8.4	8.4
Expert/science/aid service		%	6.9	6.6	6.5	6.5	6.7	6.5	6.6	6.6
Public/defense/Edu/ health/social		%	15.2	15.2	14.9	15.1	15.2	15.0	14.7	14.7
Others		%	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2

The CZ has been preparing AI apply to industry and the level of preparation is better other countries of Visegrad. The CZ has strategy in the name of IT4 Innovation to build infra ICT and preparation of 4th wave (ICT, Czech investment report 2017). Table 1. shows the comparison of the key function of 4th wave among the Visegrad countries. The CZ is AI service, PL (Poland) is AI ICT, HU (Hungary) is AI R&D, and SK (Slovakia) is AI Auto. All they have AI based 4th wave preparation. Table 2. shows the CZ's industry situation and we can see that industry portion is bigger as over 30%.

On this base, CZ built cluster to prepare 4th wave in the Prague technical University, Bruno University, and Ostrava University. They also have been educating manpower for 4th wave in these University.

The status of the CZ 4th wave preparation and policy (ICT, Czech investment report 2017): Table 2. shows the CZ's industry status.

Major portion of the CZ's industry (over 30%) is industry and service (over 18%) as Table 2. As these industries strongly depend on 4th wave 4, the CZ built strategy in the name of IT4 and with this strategy they made Digital Innovation Hubs. That is, expert or experienced manpower in robot, IoT, AI, and others can link and work with the SMC (Small and Medium Com.) in local. The EU also support this Digitalizing European Industries by committee decision on May, 2016.

One of the EU's major project is IoT and its use. Therefore, Digitalizing European supports for process of technology development by one-stop-shops, test bed, and Fab Labs show casing applications (cluster) as shown in Ref. (ICT in the Czech Republic (2017) of the CZ).

The EU committee has a plan to also support Digital Innovation Hub till 2020 and this Hub is linked with local business center and local university. The EU committee also supports this project with 500mil Euro by Horizon 2020 program,

The CZ's ICT center is Czech Invest and IBDA (the Investment and Business Development Agency). The CZ has policy to supports foreign company such as, Microsoft, Skype, NetSuite, SAP, Tieto, SolarWinds, Red Hat, IBM, and etc.

Manpower is absolutely needed to push and operate effectively the 4th wave. So, The CZ has a plan to educate for creative and innovation and experienced manpower.

With this results, Praha technical university, Bruno university, and Ostrava university nurture ICT manpower and they have 35,516 students on 2015 for ICT among 13 Universities and the number of graduated person is 7,609.

The CZ's AI research center for 4th wave: The CZ approves AI as the one of importance for 4th wave and builds several center for research.

The CZ operates for IT4 Innovations program they have a several research center such as, NRCEC (National Research Center for Extreme Computing that are researching fuzzy, statistics, bio based AI now (National supercomputing center: <http://www.it4i.cz/?lang=en>).

The Ostrava supercomputing center, which one of the most powerful supercomputers in Central Europe, researches advanced life style, nano modeling, optimized design, material design, advanced computing, and bacteria algorithm based AI.

Department of Cybernetics (EU Centre of Excellence in CZ) researches decision method by AI, Auto self-control for mechanical system. The Czech Technical University studies emotion and AI robot.

CERIT-SC (CERIT Scientific Cloud): This organizer has three purpose such as, building e-infra, interconnection of complex system, and providing memory that they want to have memory space. They research supercomputing, cloud computing, big data, and application these research center.

CESNET (Czech Education and Scientific Network): This was established in 1966 for networking among CZ universities, agency, and public communication.

SIX Research Center: This center is in Bruno city for the Center of Sensor, Information, Communication System to develop service and application of communication. They focus protocol, sensor, signal processing for A implementation and IoT industry.

NTIS: This center was established for information society by supported by EU in West Bohemia, the CZ on 2014. They have the employee of 270, which study computer, cybernetics, physics, genome, and etc. to speech, interface between machine and human, natural language, AI web, and neuro information.

Ostrava University cluster: Ostrava university has cluster to research computer network and its application.

Main research topic is on influence of environment by industry, global and region environment, and the Study of Biological Diversity in Real and Evolutionary,

Genomic Biology: They study the Evolution of Living Organisms Using Genomic and Bioinformatics Approaches, transformation of Profession.

Discourse in Cultural Contexts: They study new and innovative Types/Genres of the text, research of the identity of places and regions in literature, language and culture, the economic and social history of modern times, theory and application of fuzzy modeling.

In these research topic, there are literature, human, language, and etc. for AI developing and 4th wave.

They are studying with focus without attracting or other country's situation.

AI industry: Ministry of Industry and Trade of CZ (2016) shows the CZ industrial cluster map to make a cluster, in

this cluster, AI and IoT is doing for 4th wave and that have a strategy to support foreign company.

AVG: This company is online data, security for equipment, internet security, and mobile, and desktop security established in 1991. The number of user in the world is over 200million. This company's head quarter is in Bruno city.

AVAST: This company has so much reliability in the world in the PC security areas. The number of user is 203million and has 25 years. 600 experts in USA, Germany, China, and etc. help this company

Seznam.cz: Students Vo Lukačovic established in 1966. This company has been grown by the cause which satisfy user and promoter all. Business target focuses web search by key word and 90% of CZ use this search engine. That is, their business model has niche area from Google. From this model, we can find what we have to find.

Cooperation with the CZ and Expert method: The CZ developed in mechanical area. They have been preparing ICT and 4th wave with university through education. Therefore, for cooperation or export, we should compare analyze on what item is better and what area is better.

As one of approaches, after building a partnership through co-research by their R&D infra or education, we have to consider export.

The CZ has established in the local areas by the strategy of IT4 to reduce technology difference between local and Praha. Therefore, if Korea survey the difference of technology, we can find what technology is needed in the local or others. It means there will be a niche market and new market can be developed.

Of course, what the technology of Korean company is better than those of CZ should be surveyed and reviewed.

3.2. Analysis about Poland's 4th wave preparation

Poland built PIB (Public Information Bulletin: Polish BIP) on 2010 to extend knowledge. Poland has been introducing technology for 4th wave. They use the EU R&D fund to recover limited research fund.

Marcin Feltynowski (2012) shows selection rate of Poland in the EU R&D. The beginning of R&D was 20% but recently 13%. But it is very high than others.

Poland will use fund 82trillion Euro from 2014 to 2020. They will select special economic region 14 and invest. According to the report 2025 (EU commission: June, 2016), they will push for 4th wave such as, building of the high tech cluster, knowledge exchanging system, advanced academy and industry system, reducing of tax and barrier.

Leading technology of Poland economy is service, public product, basic material, local. Cause of development of technology is due to cluster, international cooperation, R&D with foreign company. Poland has open system that

foreigner can invest from 1990. As Poland's population is 40 million, consumer market is big. It can be attracted from investor and also low price labor and stable government is positive to foreign investor. However, negative things are low R&D investment of Poland government and innovation.

The ICT Industry status of Poland: Poland government decided prior of information society to support 5 areas of industry with targeting building of information society till 2013 on Dec. 2008. This strategy includes as follows:

HUMAN: Advanced society of Poland for knowledge and social property using public ICT solution.

ECONOMY: Increasing productivity for global market, innovation for competition, B2B communication by ICT solution and building.

STATE: Increasing service and effectiveness of public management by ICT solution. This report point out that the digital world and the smart world will be soon in front of our life. This reports mentions that intelligence, smart solution, IoT, and etc. change our custom and quality of work as well as action, and create new job. It influences on social pattern and economy. It mentions that ICT is pushing to digitalized society like flywheel. It also emphasizes they should support to build information society because it is impossible to make a life without smart phone, tablet, ultra-note book.

Marcin Nowacki (2015) represents that ICT area required of R&D in Poland. There are much required in S/W and the reference on how we should approach for export and new market. The digital index of Poland is higher than those of EU average by results of building for e-administration from 2008 to 2014. For this building, Poland invests total 1-trillion during 2014-2020 and the EU portion is 80% among this fund.

First, Poland government decided invest high speed internet, e-government and openness government, social consensus for digital, and technology supporting. Poland has a plan that 70% of home will use broad band internet till 2015 and all home will use till 2020.

Poland has the higher ERP (enterprise resource planning) index of Visegrad. As Poland has 56% of Belgium, 80% of CZ or Slovakia, and 120% of Hungary. they have a low index. So, Poland is pushing to build digitalized society as follows;

Firstly, Building digital education in each step

Secondly, recommend producing data and on-line service at public research center.

Thirdly, Supporting education of each person

Fourthly, reducing tax when buying innovative product

Fifthly, supporting for building broad band

Poland a plan to invest 32trillion PLN at 2015 and it is increased 20% than 2014.

Buying pattern at Poland is changing to mobile and 50% of venture is ICT area. Because of this reason, Poland

announces law about 20 areas of ICT on March 5, 2007. By this supporting, Poland has market share 76% at EU-ICT market and the number of ICT company of Poland ranks 5 at the EU. The turnover of these company has been increased with 10.1% every year from 2009 to 2014.

Table 3: The total turnover per manpower at ICT

Country /Year	2011	2012	2013	2014	current (co-rate)
GE	3812	4061	3947	3931	1
IT	2805	2647	2678	2856	3
SK	2257	2561	2635	2712	2
PL	1819	1930	1952	2189	4

The ICT of Poland gives a lower influence on the GDP than 11.5% of Hungary, 8.4% of Germany. The number of employee at ICT area is 4%, it is lower than 5.2% of Germany, 9.2% of Denmark, 7.2% of Finland. It means the ICT of Poland can have a space to develop.

Table 3. represents the turnover per manpower in ICT area (Unit: thousand Euro) (EU commission, e-Government in Poland, Edition 18.1, 2016). As Poland is 2,189,000Euro, it is 55.68% of Germany, 80.71% of Slovakia. It is the important fact when Korea wants to build cooperation and investment.

Some analysis-expect the positive idea about ICT of Poland because the number of employee is increasing, the number of new service center is creating, and labor price is slowly increasing than other countries even though the low labor productivity of Poland.

The labor price of Poland is lower than those of other countries such as, the CZ, Hungary, and Slovakia as 1,043million Euro at 2014. This cost is the increased cost of 27.9% than that of 2010. Slovakia is the increased cost of 39.6%, Germany is the increased as point of 29%. Even Bulgaria is the increased cost of 51.7%.

Table 4. represents the weight of R&D investment at ICT (Unit: PLN million) in Poland.

Table 4: Investment ratio of R&D

Y/Area	ICT service	ICT product	total ICT product/ service
2011	1173.9	87.5	1261.4
2012	1100.9	85.9	1186.8
2013	893.7	79.7	973.5
2014	1421.6	104.9	1526.5
-			
current co-rate	75	25	100

The Intelligent transportation of Poland: In July 7, 2010, the EU ITS (Intelligent Transport System) committee reports their direction and policy as code 17, chapter 3.

Poland issued the more detailed direction and implementation method by using EU policy. Poland defines the intelligent transportation as IT3 and have a plan till 2030 to build safety. Poland has been preparation the information of transportation as one of preparation for 4th wave and IoT.

AI R&D Status of Poland: Poland is educating S/W such as, Java, NET, C, Objective C, CSS, Javascript, and etc. as AI building infra and R&D. Poland had ever had project in the name of SOCRATES by using EU fund for AI R&D during 4-years (Jan. 2008 to Feb. 2011) with 4,980,437Euro. This project was by themselves (Poland) organized for communication network, human interface, performance optimization, and etc. As performance optimization is the core technology of AI, Poland studied earlier than Korea. Poland had a project about data mining for core of big data in the name of ADMIRE with 4,241,573 Euro.

As AI research, they studied in the name of SERVICE WEB 3.0 during 2 years (Jan 2008 ~ Dec 2009) In this project, they deal with H/W, S/W, and network structure which was optimal control by AI to improve 40-time speed of the traditional internet.

For the AI internet, they invest 2,890,000 Euro for the advanced internet performance and the id searching of intrusion, As the AI robot, there was a project in the name of STIFF-FLOP, which was invested with 7,350,000Euro during 4-years (Jan. 2012 ~ Dec.2015). This project studied manipulator such as, control, sensing, recognition, and others by biotechnology approaches. This project had a target which did make and test to build a business through cooperation of engineer, bio-scientist, medical engineer, and others.

WEKNOWIT: This project was done, which is an effective information getting method and distribution by AI during 4-years (Jan. 2008 ~ Dec. 2011) with 5,367,909 Euro.

SOCIONICAL: This project is for environment monitoring system such as, modeling, perspective, monitoring, etc. by AI with 5,299,998Euro. during 4-years (Jan. 2009 ~ Dec. 2013), which is for self-decision and operation of environment system by ICT.

NEUNEU (Artificial Wet Neuronal Networks from Compartmentalized Excitable Chemical Media): This project was done during 4-years (Jan. 2010 ~ Dec. 2013) with 2,334,698 Euro, which is for information getting by chemical analysis.

GUARDIAN ANGELS: This project is one of health monitoring system and medical, which was done during 2-years (Jan. 2011 ~ Dec. 2012) with 1,746,111Euro for physical angels, environmental guardian angels, emotional guardian angels, and etc. This project studied the personal characteristics and education, personal language characteristics, which can be used in education, security, pintech, AI, and etc.

DORII has purpose for environmental monitoring and getting a big data by sensor network.

EGI-INSPIRE: This is project for distributed computing and storage resources during 50months (Jan. 2010 ~ April. 2013) by 24,274,720Euro.

LITES: This is intelligent power control project in street illuminance sensor for 50-months (Jan. 20019 ~ May. 2012) with 2,560,000Euro.

AI Business strategy of Poland: Poland has a strategy. For this they have incubator load map from Figures.

Cooperation method and Export strategy: Poland have been preparing with topic Industry 4.0. For this they issued report which relation between labor price and productivity of Poland. on Aug. 2017. Poland has a strong relation between export and property in Poland companies, which is described by this report.

According to this report, the weakness of Poland companies can be strong in the Korean companies. It means if Korean companies analyze this relation more detail, Korean companies can have a chance to export and can develop niche market. If Poland has a strong but has a weakness in property, it can be also chance or niche to export as Korean companies.

As Poland labor price of ICT area in 2014 is about 4,043 Euro, it is 25% of Germany. Poland has higher selection ration in R&D of EU than those of other countries in EU. Therefore, Korea can have a good chance if Korea use this useful situation. That is, because Poland has many advantages in R&D situation of EU, first, Korean build partnership or human network through R&D together and push to the market as second. There will be many chance in export, job, and R&D.

Productivity will be different between company and research. For decreasing this gap, the EU committee allocates 82.5trillion from 2014 to 2020 to support the economy, social change, and effective administration shown as Table 5. of Poland.

To export effectively, first, building human networking and a cooperation system through co-research, second, selecting item and export. As the simple strategy for developing marketing is not easy because market is not big, there are many cheaper China products and overlap in very where.

Table 5: EU invest to Poland area

No.	Item	Euro (trillion)	co-rate
1.	Infra and Environ	EUR 27.4	1
2.	smart growth	EUR 8.6	0.3138
3.	education for knowledge	EUR 4.7	0.1715
4.	digitalization	EUR 2.2	0.0802
5.	eastern Poland	EUR 2.0	0.0729
6.	technology support	EUR 0.7	0.0255

3.3. Analysis about the 4th wave preparation of Hungary

The Ministry of National Economy of Hungary organized by 30 members (CEO of SME, Professor, Research center, others) on Spring of 2016 for preparation of 4th wave. Its chair organizer was MTA SZTAKI and they prepared for 3-months about 25-areas and submitted to Hungarian government in the name of Hungary platform 4.0.

As the Hungarian Industry 4.0 is National Technological Platform, it is Hungarian 4th wave platform. They have the strategy in 7-areas as follows;

Firstly, Strategic Planning

Secondly, Employment, Education and Training

Thirdly, Production and Logistics

Fourthly, ICT technologies: safety, reference architectures, standards

Fifthly, Industry 4.0Cyber-physical Pilot systems

Sixthly, Innovation and Business Model

Seventhly, Legal Framework

Hungarian strategy: Hungarian strategy is shown in Figure 10., which has the strategy in 4-areas and ICT has basic technology.

Table 6: Index of 4th wave preparation in Visegrad

Country	a	b	c	d	e	f	g	h
EU28	558.4	2.03	163.03	30.92	1.14	37.9	3.66	17
Den	1413	3.08	269.23	77.48	2.02	44.9	3.86	26
FI	1194.6	3.17	191.33	58.15	1.95	45.3	6.66	15
GE	2016	2.84	231.10	43.48	1.43	31.4	3.68	23
CZ	294.0	2.00	85.80	24.45	1.22	28.2	4.12	27
HU	144.7	1.38	53.35	7.09	0.84	34.1	4.85	10
PO	101.6	0.94	84.78	34.27	0.60	42.1	3.05	10
SK	123.6	0.89	61.30	10.89	0.65	26.9	4.10	12

Hungary has the index of 4th wave in Visegrad. In table, each letter has mean as follows:

(a) R&D per population consumption (EU)

(b) total R&D to GDP

(c) registered trademark submitted per mil population

(d) design submitted per mil population

(e) the number R&D to economic activity

(f) higher level % in 30-40 years %

(g) the number of ICT experts (%) per total employee

(h) e-promotion for business (%)

Table 6. shows that Visegrad has lower index to Finland or Germany.

Hungary has smart specialization strategies: RIS3 or S3, which should be done for 2014-2020 by network based R&D, innovation, and social program as shown in Table 7. The EU committee also is supporting code in EU1303/2013.

Table 7: Hungarian special strategy

Country	Status	%
System science	Knowledge	70
	Industrial product	20
	Low S&T	10
Smart product	Knowledge	20
	Industrial product	60
	Low S&T	20
Sustainable society	Low knowledge	10
	Industry	20
	Low S&T	70

ICT Strategy: Hungary has strategy as the important tool of 4th wave's and the implementation contents as follows:

Key Converged Field: smart business + company, home + smart city, information security, security technology, simulation and optimization technology, e-learning systems, big data, data mining, software development, remote monitoring system, cloud computing, intelligent transport, development of mobile applications, location-based services, 3D GIS, bioinformatics, IoT (Internet of things), 3D printing, future internet + 5G technologies, remote sensing, computer-based instruments and measurement and process, control improvements, numerical modelling and simulation, machine learning, data centers, data transmission networks, etc.

The above item is for key technology for AI of 4th wave.

AI application in Hungary: Hungary started to research AI application to industrial area as machine learning (Turán, 1993), multi-agent (Varga, 1994), neural network (Duray, 1993), language knowledge (Gordos, 1992).

AI S/W development: They developed ALL-EX PLUS, GENESYS, MProlog, IQSOFT for general usage. As solution, there are many S/W such as, KFKI MSZKI, ARAMIS, GDSS, METABOLEXPART, CompuDrug, PANGAEA, REALEX, ZEXPERT, IQSOFT, and etc.

Hungary AI S/W competition: Hungary has the strong AI S/W in the world, which CS-Prolog Professional had been used till 1996 in 14-countries in the world. Now, hypenators and thesauri are using by MS permission.

Hungary AI education system: The Budapest University of Economic Science (BKE) started from the beginning of 80.

Table 8: Hungarian ICT incubator

Name	Geographical	Industry focus	Capacity
ACME	International	digital, finance, life science	-
Aquincum	Bulgaria, Romania, Germany, Japan, Anglia, USA	ICT, biotech, med-tech	10 project/year
AVEC	Dan francisco, New York, Tokyo, London, Israel	ICT, biotech, med-tech, design	10 project/year

DBH SeedStar	Central EU, Holland, Azerbaijan	Life-tech, green-tech	-
Digital factory	-	ICT	21 project/year
Kitchen Budapest	USA, Western EU	No specialization	6 project/year
iCatapult	USA East, EU, Asia	ICT	Parallel 7 projects
Incubo	International	ICT, Media	5 project/year
InQbator	USA East, EU, Asia	ICT	Parallel 7 projects
Myco	EU	Green-tech, clean-tech	40strat up projects/year
Traction	USA	ICT, med-tech	50 projects/2years

Kandó Polytechnic of Technology, KKMf, Eötvös Loránd University, ELTE, etc. started the middle of 80 for AI education. Hungary has strategy to introduce ICT and AI into everywhere and built incubator as summarized in Table 8.

Strategy for export activity: Korea should have strategy through R&D together with Hungary. Because they have the lower labor price, small market, and well educated manpower.

Table 9: Hungary SWOT

<p>Strengths</p> <ul style="list-style-type: none"> • Small export company over 100com. • ICT strong to GDP rank 5th in OECD • Internationally famous Hungarian ICT experts • ICT strong impact to all industry • Venture and SSCs have culture 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Lower speed linked with EU • Lower productivity by ICT • ICT experts content low impact on market • ICT investor limited • No strategy to export • Not interest export • Not interested in exhibition • Low global ICT link
<p>Opportunities</p> <ul style="list-style-type: none"> • 4th wave can be strong with Germany • Young trend select ICT • New market for ICT 	<p>Threats</p> <ul style="list-style-type: none"> • Leaving ICT experts from Hungary. • Not follow digital market • Germany digital market embrace • Low investment

Also, Hungary had mentioned 4th wave preparation of Korea. It means they need to have a bench marking for technology and introduce Korean company or engineering into Hungarian agency or company. Another word, Korea can have niche or new market. Therefore, first, make cooperation system through co-research, and then survey niche market and select export item or technology.

Table 9. shows Hungarian incubator, which has specified technology in the region. So, Korea can have branch office or simple R&D in there and then can find niche or R&D item that they are needed with small investment.

Table 10. shows Hungarian company's SWOT. If Korean company analyze this SWOT, they can find more easily market or method.

CZ	AA- Stable	A1 Stable	A+ Positive	A+/AA- Stable	0
SK	A+ Stable	A2 Stable	A+ Stable	A Stable	0
BU	BB+ Stable	Baa2 Stable	BB+ Stable		4
RO	BB- Stable	Baa3 Stable	BBB- Stable		3

4. Analysis about Slovakia's 4th wave preparation

Slovakia has slogan "Through Knowledge to Prosperity", which was adapted as code 665 on 2013. This strategy has Research and Innovation Strategy for Smart Specialization: RIS3

This RIS3 focuses on innovation in R&D. For this, they have Smart specialization by code 665/2013.

In Slovakia, Kosiche city has a strong cluster with Kosiche Technical University. This is the best place to cooperate for ICT because, there are many government offices (over 30 offices) and ICT R&D center, and KIA motor near this city. They report that over 6,000 job was created from this place.

Table 10: ICT investment in Visegrad

Country	Lwa/ Political	Produce	Language	Data/ IPSecurity	co- point rank
Czech Republic (CZ)	Good	Good	Good	Very good	(1)17
Poland (PO)	Very good	Good	Good	Fair	(3)16
Slovakia (SK)	Good	Good	Very good	Good	(1)17
Hungary (HU)	Good	Good	Fair	Good	(4)15
Romania (RO)	Fair	Good	Good	Fair	(5)14
Bulgaria (BL)	Fair	Very good	Fair	Fair	(5)14
Ukraine (UK)	Poor	Good	Fair	Poor	(7)11
Belarus (BL)	Poor	Good	Poor	Poor	(8)10

Table 11: The credit of Visegrad

Country	Standard & Poor's	Moody's	Fitch	Rating & Investment	OECD national risk
HU	BB+ Stable	Ba Stable	BB+ Stable	BBB- Stable	4
PO	BBB+ Negative	A2 Stable	A- Positive	A-/ A Stable	0

Table 10. Gartner (2013) represents the environment of ICT investment in Visegrad country. Slovakia has a good situation in education, labor productivity, and language. Also, Slovakia is a higher credit for investment. Table 11. represents the credit of the Visegrad group. Slovakia has a very good as A+. Table 12. illustrates the GDP growth rate in Visegrad. Slovakia is a very higher rate.

Education: Slovakia invests in education for ICT activity. Table 12. shows strategic flows for ICT infra. That is, they want to make an information flow system by advice, university, network, venture, and association. They are going to build education (nurture) system as the core method through this infra.

Table12: The GDP growth rate in Visegrad

Country	2016(%)	2017(%)	current co-rank
SK	3,2	3.4	1
CZ	2.3	2.7	5
HU	2.2	2.5	4
PL	3.5	3.5	3
BL	1.5	2.0	6
RO	4.2	3.7	2

Table 13: AI and ICT education in Slovakia

Curriculum	2011		2012		co-current (co-rate)
	BS	Grad	BS	Grad	
Cognitive science	3	0	10	0	0.1
Informatics	756	15	621	14	0.4
Applied informatics	530	14	592	15	0.5
Computer engineering	150	0	143	0	0.1
Information systems	106	0	134	0	0.2
Software engineering	68	8	58	1	0.07
Artificial Intelligence	14	7	16	2	0.03
Telecommunication	489	12	469	19	0.6
Total	2116	56	2013	51	2

Table 13. shows education area in the university and the number of students in ICT.

Export strategy for Slovakia: Slovakia has a higher labor productivity and a higher language capability, both. It means they have R&D infra. and had better make a cooperation with R&D.

Table 14. represents the comparison of labor productivity in the EU. Slovakia has a good situation for cooperation in terms of ICT education and labor productivity (Gartner, 2013).

Table 14: Labor productivity

Country	2014	2015	2016	rate
EU	34,914	35,982	35,762	102%
CZ	14,535	15,109	15,947	110%
HU	11,455	11,579	12,135	106%
PL	12,487	12,699	-	102%
SK	15,090	15,557	15,830	105%
GE	38,756	39,693	40,602	105%
BE	53,855	53,877	53,850	100%
SW	71,956	81,461	79,345	110%

4. Conclusion

This paper surveys and analyzes the status of 4th wave of the Visegrad country for expert and preparation reference of 4th wave.

The CZ has the strategy in the name of IT4 and they have a good infra. Praha technical university has the main role of that and Ostrava university has strong in network. The CZ's labor price is higher among the Visegrad and Korea should have a specified export strategy for this country.

Poland has strategy to develop economy, social situation, and R&D by the EU fund. It means they need to cooperate for this development and Korea can have an opportunity.

As Poland has a higher selection rate in EU R&D program, Korea has a chance to research and develop the market through R&D together to make innovation in Poland.

Hungary has a strategy in the name of I4.0 and studied from long time ago for AI. Hungary has a small market and strong education. Korea can use this situation for export and develop niche market.

Slovakia has a small market and many good situations for investment, cooperate, credit, language, and safety. The paper suggests strongly to cooperate with Slovakia through R&D.

In 4th wave, we can expect changes in many areas, life, culture, and so on. Therefore, Korea should prepare this situation and better use the strategy of the Visegrad as reference of AI adapting big data for export, cooperation,

and R&D. And then Korea has to extend other countries in European.

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