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# Enterprises Using Radio Frequency Identification in European Union: Current Outlook (2009-2014)

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## Abstract

Implementation and usage of the latest inventions in information technology provides enterprises better position on the global market. Radio Frequency Identification (RFID) presents the innovative information technology that can change and improve many of the enterprises collaboration operations and support decision making process. The best results of RFID usage are achieved in the supply chain systems, but RFID can be applied in the fields of medicine, finance, logistics and trade. Goal of this paper is to evaluate trends and purposes of RFID usage among enterprises in European Union. We also analyse usage of RFID among Enterprises in European Union according to the industry. Future research will focus on application of RFID among enterprises worldwide and to examine are there any differences in RFID usage among developed and developing countries.

**Keywords:** Radio Frequency Identification, Technology, Enterprises, European Union Countries

**JEL classification:** C10, C38, N7

## Introduction

Many enterprises are dealing with increasingly severe global competition and to meet all challenges at the global market it is important to implement efficient business models (Fu et al, 2015). Usage of the latest information technology provides many benefits for enterprises, e.g. increase the business performances, reduce cost in human resources and increase competitiveness at the market (Chang, Chen, 2011). Radio Frequency Identification (RFID) presents the innovative information technology that can transform the current business processes and support decision making processes (Barjis, Wamba, 2010).

RFID technology was developed in 1948, but its greater usage has started by the big retailer Wal-Mart in the USA (Spekman, Sweeney, 2006). Today, the big logistics enterprise retailer adopted RFID technology, e.g. Tesco, Metro, P&G. However, there are many other industries where RFID can be used: logistics, health care, finance, supply chain, manufacturing and agricultures.

RFID technology is a form of wireless communication using radio waves which enables automatic identification of objects, collect data about them and enter those data into enterprise information systems (Fu et al., 2013; Lekakos, 2007; Chen et al., 2010).

RFID implementation in enterprises depends upon several factors, e.g. data management, existing IT infrastructure, size of enterprises. RFID technology enables

tracking and locating objects in real time, which influence on greater forecasting accuracy, reduced labour costs, shorter transportation time, higher quality of customer service, easier control of purchases and better management of inventory (Shi *et al.*, 2010; Ustundag, Tanyas, 2009).

In this paper we will take a look at recent RFID usage among enterprises and try to understand are there positive trends in 2014 compared to 2011 and are enterprises ready to use RFID technology more in the future. Goal of this paper is to evaluate trends and purposes of RFID usage among enterprises in European Union in the period of 2009 and 2011 and in the period of 2011 and 2014. In order to accomplish the goal of the paper we use data about RFID usage among enterprises in European Union for 32 European countries. Data were collected from Eurostat-European Commission Statistics Database for 2009, 2011 and 2014 year.

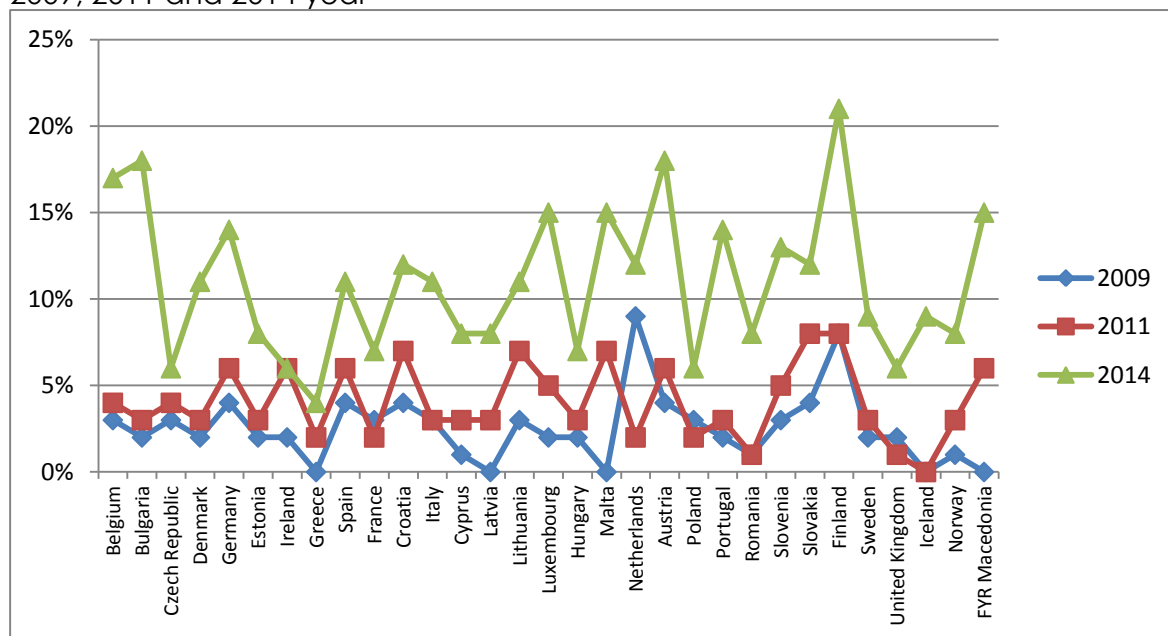
The paper is organized as follows. The first part presents an overview of Radio Frequency Identification technology (RFID) and its usage in enterprises. In the second part of the paper data and methodology have been described. Results are described in the third part. The last part of the paper is conclusion.

## Methodology and Data

Data on RFID usage were collected for 31 European countries (EU countries, Iceland, Norway and FYR Macedonia). Other European countries were not used in the analysis because of missing data for the selected variables and for the selected years. Data were collected from the European Statistics Database-Eurostat for the 2009, 2011 and 2014 year.

Graph 1

RFID usage among enterprises in European Union for 32 European countries in the 2009, 2011 and 2014 year



Source: Eurostat (2014)

The percentage of enterprises in each country that are using RFID is presented on the Graph 1. It can be concluded that there are almost no changes in RFID usage among enterprises in European countries in 2009 and in 2011. In selected countries, less than 10% of enterprises were using RFID technology in 2009 and in 2011. However, most of the European countries in 2014 showed significant progress in RFID

usage and enterprises in almost every European country started using RFID more in 2014 compared to 2009 and 2011. Enterprises in Finland showed the greatest progress in RFID usage in 2014 (21%).

In this paper we investigate the usage of RFID among enterprises in European countries. We attempt to determine are there positive changes in RFID usage in 2009, in 2011 and in 2014 year. In order to investigate trends of RFID usage we compare changes of 2011 to 2009 and 2014 to 2011. We also analysed the usage of RFID among enterprises in European countries according to the industry.

## Results

Trends of RFID among enterprises in European countries are presented in Table 1. Collected data present percentage of enterprises with at least 10 persons employed which used RFID in 2009, 2011 and 2014.

Table 1

Trends of RFID among enterprises in European countries

GEO/TIME	2009	2011	2014	change 2011 to 2009	change 2014 to 2011
<b>EU (28 countries)</b>	3%	4%	10%	1%	6%
<b>EU (27 countries)</b>	3%	4%	10%	1%	6%
<b>Belgium</b>	3%	4%	17%	1%	13%
<b>Bulgaria</b>	2%	3%	18%	1%	15%
<b>Czech Republic</b>	3%	4%	6%	1%	2%
<b>Denmark</b>	2%	3%	11%	1%	8%
<b>Germany</b>	4%	6%	14%	2%	8%
<b>Estonia</b>	2%	3%	8%	1%	5%
<b>Ireland</b>	2%	6%	6%	4%	0%
<b>Greece</b>	0%	2%	4%	2%	2%
<b>Spain</b>	4%	6%	11%	2%	5%
<b>France</b>	3%	2%	7%	-1%	5%
<b>Croatia</b>	4%	7%	12%	3%	5%
<b>Italy</b>	3%	3%	11%	0%	8%
<b>Cyprus</b>	1%	3%	8%	2%	5%
<b>Latvia</b>	0%	3%	8%	3%	5%
<b>Lithuania</b>	3%	7%	11%	4%	4%
<b>Luxembourg</b>	2%	5%	15%	3%	10%
<b>Hungary</b>	2%	3%	7%	1%	4%
<b>Malta</b>	0%	7%	15%	7%	8%
<b>Netherlands</b>	9%	2%	12%	-7%	10%
<b>Austria</b>	4%	6%	18%	2%	12%
<b>Poland</b>	3%	2%	6%	-1%	4%
<b>Portugal</b>	2%	3%	14%	1%	11%
<b>Romania</b>	1%	1%	8%	0%	7%
<b>Slovenia</b>	3%	5%	13%	2%	8%
<b>Slovakia</b>	4%	8%	12%	4%	4%
<b>Finland</b>	8%	8%	21%	0%	13%
<b>Sweden</b>	2%	3%	9%	1%	6%
<b>United Kingdom</b>	2%	1%	6%	-1%	5%
<b>Iceland</b>	0%	0%	9%	0%	9%
<b>Norway</b>	1%	3%	8%	2%	5%
<b>FYR Macedonia</b>	0%	6%	15%	6%	9%

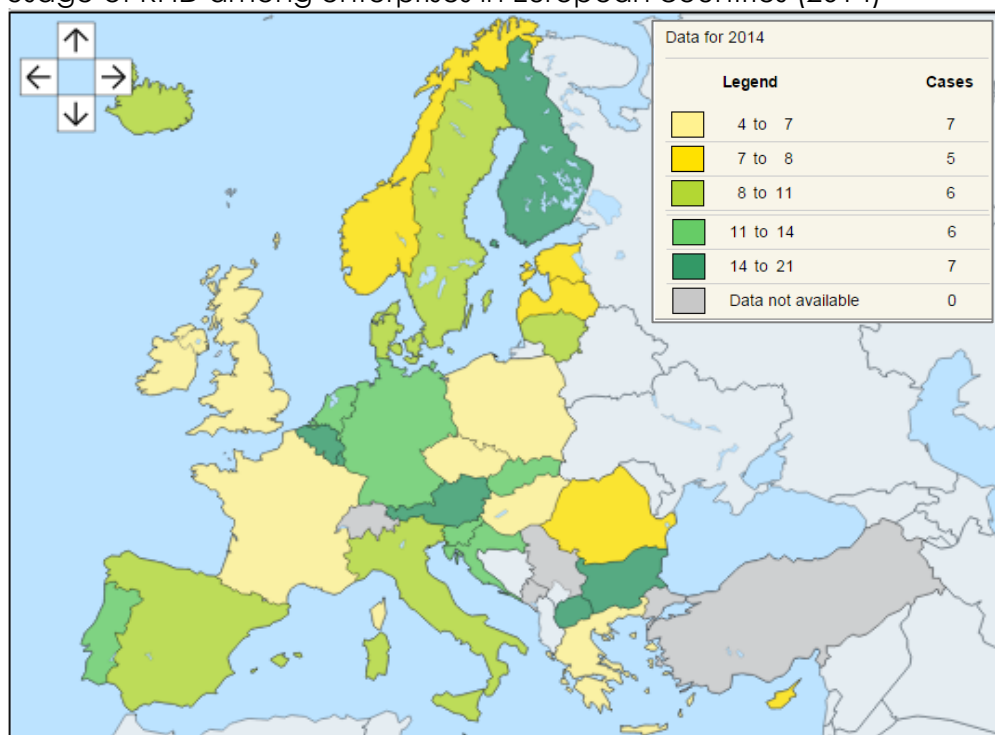
Source: Authors' calculation based on Eurostat (2014)

In 2009 enterprises from Netherlands (9%) and Finland (8%) used RFID technology the most compared to other European countries. In many countries, about 4% of enterprises were using RFID technology (Germany, Spain, Croatia, Austria, Slovakia). There are also some developing European countries, where RFID technology have not been used at all (Greece, Latvia, Malta, Iceland and FYR Macedonia). The situation is almost the same in 2011 compared to 2009 year. Iceland is the only country where enterprises have not been using RFID in 2009 neither in 2011. In Finland, Romania and Italy the usage of RFID among enterprises was the same, and there was no changes in 2009 and in 2011 year (Finland-8%, Romania-1%, Italy-3%). The RFID usage was lower in 2011 than in 2009 year in France, Poland and United Kingdom (1 percentage point), while, in Netherlands the the decline of RFID usage among enterprises was 7 percentag points.

In 2014 in most of the European countries, the RFID usage among enterprises was higher than 15% (Belgium-17%, Bulgaria-18%, Malta-15%, Austria-18%, FYR Macedonia-15%). Enterprises in Finland used the RFID technology the most in 2014 year compared to other European countries (21%). Comparing changes from 2014 to 2011 there was no negative trends in RFID usage among countries. Only in Ireland was stagnation, the usage of RFID among enterprises was the same in 2011 and in 2014 (6%). The highest progress in RFID usage among enterprises was in the developed European countries (Belgium-13%; Luxembourg and Netherlands-10%; Austria-12%; Finland-13%). However, positive trend of RFID usage among enterprises in developing countries can be seen in Bulgaria in 2014 year (18%) compared with 2011 year (3%), rise of 15 percentage point.

Figure 1

Usage of RFID among enterprises in European countries (2014)



Source: Eurostat (2014)

Usage of RFID among enterprises in European countries in 2014 is presented on Figure 1. In Finland, Bulgaria, Austria and Belgium the usage of RFID among enterprises is the highest, while United Kingdom, France, Greece, Poland show the lowest level of RFID usage among enterprises.

Table 2

Usage of RFID among enterprises in European countries according to the industry

GEO/TIME	M	E	C	T	TS	A	S	SS	ICT
EU28	13	18	5	10	11	9	9	9	20
EU27	13	18	5	10	11	9	9	9	20
Belgium	:	:	14	16	20	:	20	6	25
Bulgaria	18	31	11	15	15	26	31	19	49
Czech Republic	8	8	1	5	5	6	5	6	13
Denmark	10	:	7	10	15	:	12	9	18
Germany	24	25	6	11	11	7	11	10	28
Estonia	10	12	6	6	12	10	8	6	27
Ireland	9	19	4	6	16	5	4	4	12
Greece	:	:	:	:	:	:	:	:	:
Spain	15	18	6	13	14	8	9	7	12
France	9	9	2	8	7	9	5	6	13
Croatia	14	11	5	11	13	20	8	20	32
Italy	12	19	5	12	14	11	10	12	17
Cyprus	5	20	2	9	20	9	12	5	24
Latvia	8	10	5	7	8	9	14	11	24
Lithuania	9	18	10	8	18	18	11	19	18
Luxembourg	19	36	9	19	14	14	19	12	21
Hungary	8	16	4	7	13	10	9	6	15
Malta	12	:	14	11	20	18	15	19	37
Netherlands	14	18	8	13	15	12	12	7	23
Austria	26	29	10	17	21	26	20	14	46
Poland	6	12	4	5	7	10	6	9	19
Portugal	14	20	8	20	:	20	12	:	22
Romania	8	13	5	7	7	7	14	9	21
Slovenia	17	21	4	11	8	34	17	14	31
Slovakia	17	17	6	8	10	12	12	10	22
Finland	23	32	16	23	14	20	20	23	30
Sweden	8	30	5	9	9	6	10	9	19
United Kingdom	8	11	4	4	8	1	5	9	18
Iceland	8	12	5	13	11	7	11	16	15
Norway	8	18	6	7	8	12	12	11	18
FYR Macedonia	:	18	6	17	12	11	:	:	:

Source: Eurostat (2014)

Note: Manufacturing-M; Electricity, gas, steam, air conditioning and water supply-E; Construction-C; Wholesale and retail trade, repair of motor vehicles and motorcycles-T; Transportation and storage-TS; Accommodation-A; Professional, scientific and technical activities-S; Administrative and support service activities-SS; ICT sector-ICT

Usage of RFID among enterprises in European countries according to the industry is presented in Table 2. Usage of RFID among enterprises in Manufacturing industry (M) was the highest in Austria (26%) and the lowest in Cyprus (5%). Usage of RFID among enterprises in Construction (C) industry was the highest in Finland (16%) and the lowest in France and Cyprus (2%). Enterprises from Wholesale and retail trade, repair of motor vehicles and motorcycles (T) industry use RFID the most in Finland (23%) and the least in the United Kingdom (4%). In Transportation and storage (TS)

industry as well as in the Electricity, gas, steam, air conditioning and water supply (E) industry the lowest percentage of RFID usage among enterprises was in Czech Republic (5%). More than 30% of enterprises used RFID in Luxembourg regarding electricity industry (E), while approximately 20% used it in Austria regarding transportation industry (TS). In Accommodation (A) industry, enterprises from Slovenia (34%) used the RFID technology the most while enterprises from the United Kingdom (1%) and Iceland (5%) used it the least. Enterprises in Finland (23%) used the RFID technology the most in Administrative and support service activities (SS), while in Ireland only 4% enterprises used RFID technology in the same industry (SS). In ICT sector and in Professional, scientific and technical activities (S) usage of RFID among enterprises was the highest in Bulgaria and the lowest in Ireland.

Table 3

Purposes for RFID among Enterprises in European countries (2014)

GEO/TIME	Enterprises using RFID for person ID	Enterprises using RFID as part of production/service delivery process	Enterprises using RFID for after sales ID
EU28	8	3	2
EU27	8	3	2
Belgium	14	5	2
Bulgaria	13	8	5
Czech Republic	5	0	1
Denmark	9	2	2
Germany	12	4	1
Estonia	7	2	1
Ireland	4	4	2
Greece	3	2	:
Spain	7	6	3
France	5	2	1
Croatia	10	4	3
Italy	8	4	2
Cyprus	6	2	2
Latvia	7	2	2
Lithuania	7	5	3
Luxembourg	12	4	2
Hungary	5	3	2
Malta	12	4	4
Netherlands	10	3	2
Austria	16	5	2
Poland	5	2	1
Portugal	9	7	4
Romania	5	4	1
Slovenia	10	3	3
Slovakia	11	2	2
Finland	18	4	4
Sweden	8	2	1
United Kingdom	5	1	1
Iceland	7	3	2
Norway	7	2	1
FYRMacedonia	13	6	5

Source: Eurostat (2014)



Purposes for RFID among Enterprises in European countries in 2014 are presented in Table 3. The most enterprises which are using RFID technology for person identification are in Austria (16%) and in Belgium (14%), while enterprises from Ireland (4%) and Greece (3%) used the RFID technology the least for person identification compared to other European countries in 2014. In Bulgaria (8%) and Portugal (7%) enterprises are using the RFID technology as part of production/service delivery process the most, while in the United Kingdom only 1% of enterprises used the RFID technology as part of product/service delivery process. There are less than 5% of enterprises in European countries which used the RFID technology for after sales identification. The only two exceptions are FYR Macedonia and Bulgaria where the usage of the RFID technology for after sales identification among enterprises is 5%.

## Conclusion

In this paper our main goal was to analyse RFID usage among enterprises in European countries in 2009, 2011 and in 2014 year. We also evaluate purposes of RFID usage among enterprises in European countries and differences in RFID usage among enterprises according to their industry.

Results of our analysis showed positive trends in RFID usage among enterprises in European countries in the last five years. In 2011 enterprises in almost every selected European country used RFID more than in 2009, but still less than 10% of enterprises were using RFID technology in 2009 and in 2011. However, during period of three years (2011-2014) many enterprises made significant progress in RFID usage which resulted that the RFID usage among enterprises was higher than 15% in most of the European countries, especially in developing countries. Finland can be highlighted as the best example while 21% of enterprises used the RFID technology in 2014. Beside Finland, it is important to highlight developing countries Bulgaria and FYR Macedonia, where significant growth in RFID usage was perceived. Furthermore, results of our study showed that there are differences in RFID usage among enterprises in European countries according to the industry. In ICT sector and in Professional, scientific and technical activities (S) usage of RFID among enterprises was the highest in Bulgaria and the lowest in Ireland. Enterprises in Finland used the RFID the most in Wholesale and retail trade, repair of motor vehicles and motorcycles (T) and in Administrative and support service activities (SS). RFID usage among enterprises was the lowest in Construction (C) and Transportation and storage (TS) industries. Analysis of purposes for RFID among enterprises showed that enterprises used RFID technology the most for person identification and as part of production/service delivery process and the least for the after sale identification. Results again showed that enterprises in Bulgaria have great potential of purposes for RFID usage, while many developed European countries are lagging behind (United Kingdom, Sweden).

Results of our study indicated that there are positive trends in RFID usage among enterprises in European countries, especially in developing countries. Therefore, the conclusion regarding research results could be that the level of RFID usage among enterprises in particular European country is not directly related to the economic development and level of competitiveness and not even with the development and usage of ICT. However, detailed and expanded analyses are required in order to investigate what is the relationship between economic development and RFID usage while developing countries (Bulgaria) use the RFID technology more than developed countries (United Kingdom). In order to broaden further research, investigation about national policies regarding RFID usage among enterprises should be examined.



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