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INNOVATION: ASSESSING THE VARIABLES INFLUENCING BUSINESS PROCESS AND PRODUCT INNOVATION

BY

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Abstract. Innovation has become a must for companies to improve their organizational resilience, to increase their financial performance and to respond to external challenges. Based on the object being innovated, innovation can be classified in two types: product innovation and business process innovation. A product innovation can trigger the need for a business process innovation, resulting in the two types being intertwined in practice. Since innovation triggers economic growth, both companies and countries are looking into generating more innovation by policies, activities and funding. To evaluate whether their endeavours are reaching their targeted goals, they need to measure innovation. Organisation for Economic Co-operation and Development (OECD)/Eurostat are providing a standardized approach to evaluate innovation across organizations and countries, enabling not only measurement, but also comparative analysis between entities. This approach includes a standardized questionnaire, which is applied in more than 80 countries, and is continuously improved based on the feedback obtained. The results obtained by applying this questionnaire, which were published by OECD, represent the data used in this research. By using a quantitative methodology, this study explores the variables that influence business process innovation and product innovation. The hypotheses are multifold and have been tested using statistical methods. Firstly, the study analyses whether the research and development (R&D) expenditures influence both business process innovation (H1) and product innovation (H2). Hypotheses H1 and H2 are invalidated by

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statistical means. Secondly, the research assesses whether the share of persons employed in innovation-active firms, in total employment in 2020, has an influence on both business process innovation (H3) and product innovation (H4). Both hypotheses (H3, H4) are validated statistically, showing a positive influence between the analysed variables. Thirdly, the study proves whether the turnover of the firms is influenced by product innovation (H5) and by business process innovation (H6). Hypotheses H5 and H6 are validated statistically. The conclusions of this research expand the existing scientific knowledge in innovation, by revealing the relationships between business process innovation, product innovation, R&D expenditure, share of employees and turnover of the firms. It also provides recommendations for managers aiming to increase innovation and turnover.

Key words: Product Innovation, Business Process Innovation, OECD survey, R&D expenditures, Turnover.

1. Introduction

Innovation is of high interest for countries and companies world-wide due to the major impact it can have. At society level, innovation can improve the living standards of people and countries, while also being key to solving the complex global challenges that society faces today (OECD & Eurostat, 2018). At company level, innovation is key to ensure the long-term sustainability, competitive advantage of the company and economic growth (Aagaard and Vanhaverbeke, 2024; OECD & Eurostat, 2018; Şimşek *et al*., 2022). It is also vital to respond to external changes and challenges, for example digital technologies, competitors, market, regulations, etc. (Ahokangas *et al*., 2024; Jorzik *et al*., 2024; OECD & Eurostat, 2018; Şimşek *et al*., 2022).

This research focuses on innovation in countries that are applying the "guidelines for collecting and interpreting data on innovation" from the Oslo Manual which is maintained and updated by the Organisation for Economic Cooperation and Development (OECD) and Eurostat (OECD & Eurostat, 2018). Since these countries apply the same guidelines, the collected data is the perfect dataset on which to assess innovation. Specifically, this research has two main goals. Firstly, it assesses whether innovation is influenced by research and development (R&D) expenditures and number of employees. Secondly, it assesses whether the turnover of companies is influenced by innovation. Thus, the study addresses the following research questions for the countries applying the guidelines from the Oslo Manual:

RQ1. Do R&D expenditures influence innovation?
RQ2. Does the share of employees influence innovation?
RQ3. Does innovation influence turnover of companies?

This article is structured in six sections: introduction, literature review, methodology, data and results, conclusion, references.

2. Literature review

The concept of innovation was firstly introduced by Joseph Schumpeter in the economic theory (Godin, 2008). He insists on the distinction between invention and innovation. While invention implies creating something new or improved significantly, innovation implies using the invention in practice and generating economic gains (Godin, 2008). In the initial definion, innovation implied introducing something new in terms of goods, manufacturing processes, supply chain or organization (Godin, 2008). However, while this definition seems appropriate for manufacturing companies, it does not cover well innovation in services, marketing, customer relationships, revenue streams, etc.

Organisation for Economic Cooperation and Development (OECD) proposes a more generic definition, aiming to cover these gaps. Innovation is defined as the implementation and usage of an invention or a new idea in practice (OECD & Eurostat, 2018). OECD goes a step further and defines two major types of innovation based on the innovated object: product innovation and business process innovation (OECD & Eurostat, 2018), as illustrated in Fig. 1. Product innovation implies that object of innovation is a product, which is defined as either a good or a service (OECD & Eurostat, 2018). On the other hand, business process innovation implies that the object of innovation is a business process, such as: manufacturing, distribution and logistics, information and communication systems, administration and management, product and business process development (OECD & Eurostat, 2018).

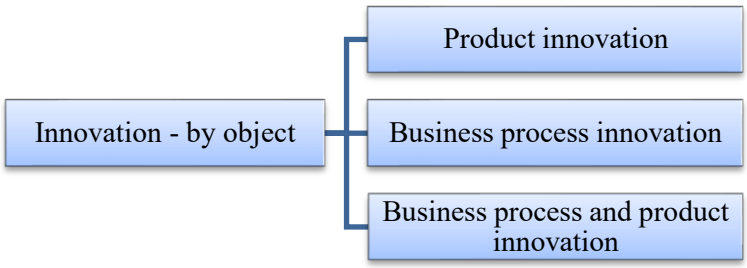


Fig. 1 – Taxonomy of innovation based on the object – synthesis from (OECD & Eurostat, 2018).

Although innovation is very important for a company, measuring it in a consistent way across companies and countries is challenging. Oslo Manual proposes a solution by providing guidelines for measuring business innovation (OECD & Eurostat, 2018). Firstly created and adopted in 1991, the manual is further improved and updated by OECD and Eurostat (OECD & Eurostat, 2018). Countries are able to apply these guidelines in their national surveys. OECD aggregates such data and publishes the corresponding dataset on its website

(OECD, 2023b). This study focuses only on countries that are applying the guidelines provided in the Oslo Manual (OECD & Eurostat, 2018), because they measure innovation in the same manner.

At the beginning of this study, a bibliometric analysis was performed and the results are depicted in Fig. 2.

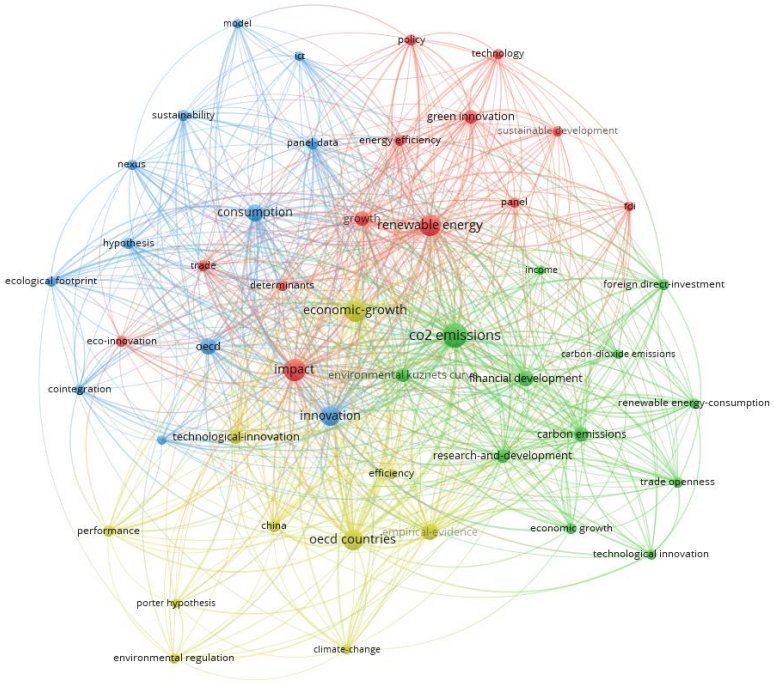


Fig. 2 – Network visualization corresponding to the bibliometric analysis done in VOSviewer.

The bibliometric analysis started with a query in the database Web of Science (WoS), using as keywords ”innovation” and ”OECD”, in March-2026, selecting only the papers were published within the last 5 years and are marked as the highest cited papers by WoS. This resulted in 182 studies, for which the full record and cited references were extracted and analyzed for co-occurence using VOSviewer version 1.6.20 (van Eck and Waltman, 2026).

The results of the bibliometric analysis reveal the existence of four major clusters within the 182 studies, that are illustrated in Fig. 2 with different colors: blue, red, yellow. The most relevant clusters for the goals of this research are the green and yellow clusters. In the green cluster, innovation is associated with R&D (“research-and-development”, “technological innovation”), which is relevant for RQ1. Innovation is also connected with financial terms not only in the green cluster (“financial development”, “income”, “economic growth”, etc.), but also in the yellow cluster (“economic growth”). This has high relevance for RQ3. The

other two clusters – the red and the blue one – go more towards the direction of environmental sustainability, which is not in the scope of this research. The clusters do not contain explicitly any term related to employees, which would have been relevant for RQ2. These results of the bibliometric analysis were used in the development of the research.

Firstly, the relationship between R&D expenditures and innovation is analyzed. The bibliometric analysis connects R&D and innovation. The scientific literature has divergent views regarding whether R&D expenditures stimulate innovation. Some authors consider R&D a major determinant of innovation (Becheikh *et al*., 2006; Lu and Wang, 2024; Raymond and St-Pierre, 2010), encouraging companies to invest in R&D activities. On the other hand, other authors argument that innovation can come from other types of activities and not only from R&D, for example market research, analysis of customer data and behaviour (OECD & Eurostat, 2018), digital technologies adoption, marketing, organization (Lu and Wang, 2024), etc. Some go even further by saying that "innovation often does not require research and experimental development (R&D) and that innovation also involves the diffusion of existing technologies and practices across an economy" (OECD & Eurostat, 2018). Taking into consideration these perspectives, this study will test the following hypotheses:

H1. R&D expenditures influence business process innovation.

H2. R&D expenditures influence product innovation.

These hypotheses aim to answer the following research question:

RQ1. Do R&D expenditures influence innovation?

Secondly, the relationship between employees in the firm and innovation is investigated. The scientific literature clearly states the critical importance of human capital for innovation (Becheikh *et al*., 2006; Bogers *et al*., 2018b). The human capital can be internal, consisting of the employees of the company, or external, when people from outside the company contribute to innovation. This is a key difference between closed and open innovation (Bogers *et al*., 2018a; Chesbrough *et al*., 2018). This study will focus only on the internal human capital by looking at the share of employees. For the countries applying the guidelines from the Oslo Manual (OECD & Eurostat, 2018), the following research hypotheses will be tested:

H3. The share of employees influences business process innovation.

H4. The share of employees influences product innovation.

These hypotheses aim to answer the following research question:

RQ2. Does the share of employees influence innovation?

Lastly, the relationship between innovation and turnover of the companies will be studied. The scientific literature recognizes that economic growth is one of the major reason why companies innovate. The economic growth refers to the desire of the firm to increase its' revenues and profits, ensuring its' long-term financial sustainability (Aagaard and Vanhaverbeke, 2024; Kogabayev

and Maziliauskas, 2017). The literature recognizes that there are other important drivers for a company to innovate besides financial ones. The societal impact would be one of the most important drivers, emphasizing that the main goal of innovation is to satisfy human needs – current or future human needs (Aagaard and Vanhaverbeke, 2024; OECD & Eurostat, 2018). External changes also drive innovation, since companies need to respond to technological progress, customer expectations and/or behaviours, competitors, geopolitical influences, regulations, market changes or other external changes impacting the firm directly or indirectly (Aagaard and Vanhaverbeke, 2024; Şimşek *et al*., 2022). This study will focus only on the financial reasons, specifically on the turnover of the companies. It aims to assess whether the following hypotheses are true for countries applying the guidelines from the Oslo Manual:

H5. Business process innovation influences the turnover of companies.

H6. Product innovation influences the turnover of companies.

These hypotheses aim to answer the following research question:

RQ3. Does innovation influence turnover of companies?

3. Methodology

The research philosophy adopted is positivism, which implies that the researchers embrace an objective, detached and neutral stance in analyzing real external facts. This study is an explanatory one, aiming to establish causal relationships between the variables analyzed. It uses deduction as the approach for developing theory. The research hypotheses are created based on scientific literature. The research is quantitative and cross-sectional.

The study focuses on countries applying the guidelines from the Oslo Manual. It uses the dataset "2023 OECD Innovation Indicators Dataset" published by OECD (2023a). The dataset includes relevant indicators for business innovation in 42 countries for the years 2018 – 2020 (OECD, 2023b). The dataset "the 2023 edition of the innovation indicators" was downloaded from (OECD, 2023a) and the contents of the archive were extracted. The file containing the data to be analysed is "innovation-indicators-2023\innovation-indicators-2023v2\Innovation Indicators\Data.xlsx".

This dataset includes 47 variables, out of which only 6 are relevant for the scope of this research. The description of these 6 relevant variables are presented in Table 1. Variable "RD" can have one of the following values – as defined in sheet „Value labels" - :"No R&D", "R&D", "TOTAL" (OECD, 2023a). The other 5 variables used in this research (BPCS_XFRMTOT, PRD_SERV_XFRMTOT, EMP20_INN_XEMP20, RNDTOT_XEXPINN, TUR_INN_XTUR20) are numerical continuous data, since they are a percentage out of the total, as also explained in the description below.

Table 1

Variables used in this reasearch

Source: (OECD, 2023a), sheet "Variable Description"

Variable	Description
RD	"R&D status (whether R&D activity was carried out in the reference period)"
BPCS_XFRMTOT	"Business process innovative firms, as a percentage of total firms"
PRD_SERV_XFRMTOT	"Product innovative firms (innovation of services), as a percentage of total firms"
EMP20_INN_XEMP20	"Share of persons employed in innovation-active firms in total employment in 2020"
RNDTOT_XEXPINN	"R&D expenditures (including in-house & contracted-out), as a percentage of total expenditures on innovation activities in 2020"
TUR_INN_XTUR20	"Turnover in innovation active firms, as a percentage of total turnover in 2020"

Based on these variables, the research hypotheses are further refined into:

H1. The percentage of R&D expenditures out of total expenditures on innovation activities influences the percentage of firms with business process innovation.

H2. The percentage of R&D expenditures out of total expenditures on innovation activities influences the percentage of firms with product innovation.

H3. The share of employees from innovative-active firms influences the percentage of firms with business process innovation.

H4. The share of employees from innovative-active firms influences the percentage of firms with product innovation.

H5: The percentage of firms with business process innovation influences the percentage of turnover of innovative firms out of total turnover.

H6. The percentage of firms with product innovation influences the percentage of turnover of innovative firms out of total turnover.

Combining these 6 research hypotheses results in the model presented in Fig. 3.

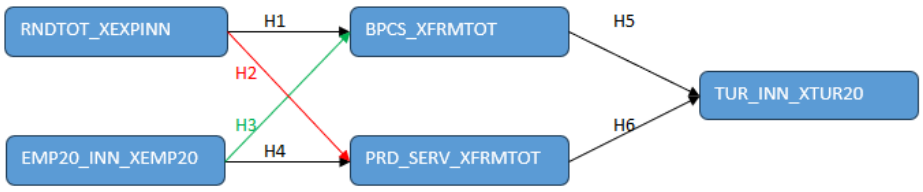


Fig. 3 – Research model proposed in this research.

After the data collection by downloading the dataset, a data clean-up was performed. The next steps of the research were to analyze the data using statistical techniques, to interpret the results, and to formulate conclusions.

4. Data and Results

This section provides further details about the data clean-up, the data analysis performed via statistical means and the results obtained.

The data clean-up was performed on sheet "Data" from Data.xlsx. Firstly, only the columns corresponding to the 6 variables of interest were kept, while other columns were removed. Secondly, all the rows that contained "TOTAL" as a value for RD column were kept, while the others were removed. Afterwards, each of the 5 columns corresponding to the remaining 5 numerical variables were inspected. Rows containing an empty cell, .c (confidential), .n (not applicable), or .u (low reliability) on any of the cells were deleted. This ensures that each row contains complete data. The resulting dataset contains 167 rows with complete information. Before the data clean-up, there were 42 countries in the dataset. After the clean-up, only 29 countries remained and are presented in Table 2.

Table 2
List of countries after data clean-up
Source: (OECD, 2023a)

No	Country Name	Country	No	Country Name	Country
1	Argentina	ARG	16	Hungary	HUN
2	Austria	AUT	17	India	IND
3	Belgium	BEL	18	Iceland	ISL
4	Bulgaria	BGR	19	Italy	ITA
5	Canada	CAN	20	Korea, Republic of	KOR
6	Chile	CHL	21	Lithuania	LTU
7	Czech Republic	CZE	22	New Zealand	NZL
8	Germany	DEU	23	Poland	POL
9	Spain	ESP	24	Portugal	PRT
10	Estonia	EST	25	Slovakia	SVK
11	Finland	FIN	26	Slovenia	SVN
12	France	FRA	27	Sweden	SWE
13	United Kingdom	GBR	28	Turkey	TUR
14	Greece	GRC	29	Uruguay	URY
15	Croatia	HRV			

After this step, the statistical analysis was performed using the software application IBM SPSS Statistics Release 22.0.0.0 (IBM, n.d.).

4.1. Reliability analysis and descriptive statistics

The Kolmogorov-Smirnov test of normality was applied to check whether the five numerical data series have a normal distribution. According to the results from Table 3, the series PRD_XFRMTOT and RNDTOT_XEXPINN have a normal distribution, while the other three (BPCS_XFRMTOT, EMP20_INN_XEMP20, TUR_INN_XTUR20) have a distribution different than the normal one.

Table 3
Tests of normality

	Kolmogorov-Smirnov		
	Statistic	df	Sig.
PRD_XFRMTOT	0.069	167	0.05
BPCS_XFRMTOT	0.092	167	0.002
EMP20_INN_OSLO_XEMP20	0.085	167	0.005
RNDTOT_XEXPINN	0.064	167	0.091
TUR_INN_XTUR20	0.085	167	0.005

Afterwards, the indicators of central tendency were generated and analyzed. Table 4 contains information about mean, median, mode, percentiles.

Table 4
Descriptive statistics for central tendency

		PRD_ XFRMTOT	BPCS_ XFRMTOT	EMP20_INN_ OSLO_XEMP20
N	Valid	167	167	167
	Missing	0	0	0
Mean		31.21477223	47.92032192	64.92030818
Median		28.75270911	47.47292419	67.02396544
Mode		28.50003736	19.84143545	54.36096676
Percentiles	25	19.41303177	27.5673662	54.43856549
	50	28.75270911	47.47292419	67.02396544
	75	40.36712841	62.29050279	78.62353696

Table 4
Descriptive statistics for central tendency – continued

		RNDTOT_ XEXPINN	TUR_INN_ XTUR20
N	Valid	167	167
	Missing	0	0
Mean		55.25266965	72.45193928
Median		58.82381661	75.5855737
Mode		11.75907393	70.95599398
Percentiles	25	38.21033336	62.43408611
	50	58.82381661	75.5855737
	75	75.90827191	86.88624733

Variability was analyzed next by looking at the standard deviation and the coefficient of variation. According to Table 5, the series PRD_XFRMTOT and TUR_INN_XTUR20 have the lowest variability out of the series analyzed. On the other hand, BPCS_XFRMTOT has the greatest coefficient of variance, which reflects the highest variability out of the series analyzed.

Table 5
Standard deviation and coefficient of variance

Variabilă	Std. Deviation	Coefficient of variance
BPCS_XFRMTOT	15.849181901506400	0.508
EMP20_INN_XEMP20	20.925024619139600	0.437
PRD_XFRMTOT	19.078276643248700	0.294
RNDTOT_XEXPINN	24.253432023274000	0.439
TUR_INN_XTUR20	19.406893875609600	0.268

Next, the skewness and kurtosis were analyzed, the results being presented in Table 6. The skewness is positive for variables PRD_XFRMTOT, BPCS_XFRMTOT, and negative for EMP20_INN_OSLO_XEMP20, RNDTOT_XEXPINN, TUR_INN_XTUR20. The kurtosis is positive for EMP20_INN_OSLO_XEMP20, TUR_INN_XTUR20, and negative for PRD_XFRMTOT, BPCS_XFRMTOT, RNDTOT_XEXPINN.

Table 6
Skewness and kurtosis

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
PRD_XFRMTOT	0.629	0.188	-0.098	0.374
BPCS_XFRMTOT	0.316	0.188	-0.607	0.374
EMP20_INN_OSLO_XEMP20	-1.002	0.188	1.218	0.374
RNDTOT_XEXPINN	-0.348	0.188	-0.77	0.374
TUR_INN_XTUR20	-1.338	0.188	2.388	0.374

4.2. Hypotheses testing

Hypotheses testing was done using linear regression and the results are presented below for each hypothesis.

H1: The percentage of R&D expenditures out of total expenditures on innovation activities influences the percentage of firms with business process innovation.

This hypothesis was tested using linear regression and results are shown in Fig. 4. The independent variable is RNDTOT_XEXPINN and the dependent variable is BPCS_XFRMTOT.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.223[a]	.050	.044	20.45990883

a. Predictors: (Constant), RNDTOT_XEXPINN

b. Dependent Variable: BPCS_XFRMTOT

a) Model Summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3613.906	1	3613.906	8.633	.004[b]
	Residual	69070.298	165	418.608		
	Total	72684.205	166			

a. Dependent Variable: BPCS_XFRMTOT

b. Predictors: (Constant), RNDTOT_XEXPINN

b) ANOVA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	37.291	3.949		9.443	.000
	RNDTOT_XEXPINN	.192	.065	.223	2.938	.004

a. Dependent Variable: BPCS_XFRMTOT

c) Coefficients

Fig. 4 – Results of testing H1 using linear regression.

From table "Model Summary" (Fig. 4a), R is equal to 0.223, which implies that there is a weak positive correlation between RNDTOT_XEXPINN and BPCS_XFRMTOT. R Square is 0.05, indicating that 5% of the total variation of the dependent variable (BPCS_XFRMTOT) can be explained by the independent variable (RNDTOT_XEXPINN), which is low.

From table "ANOVA" (Fig. 4b), Sig. is equal to 0.004 < 0.05, which is statistically significant.

From table "Coefficients" (Fig. 4c), Sig. for (Constant) is 0.000 < 0.05 and Sig. for RNDTOT_XEXPINN is 0.004 < 0.05, both being statistically significant.

The corresponding econometric equation is:

(1) $\text{BPCS_XFRMTOT} = 0.192 * \text{RNDTOT_XEXPINN} + 37.291$

H2: The percentage of R&D expenditures out of total expenditures on innovation activities influences the percentage of firms with product innovation.

This hypothesis was tested using linear regression and results are shown in Fig. 5. The independent variable is RNDTOT_XEXPINN and the dependent variable is PRD_XFRMTOT.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.225[a]	.051	.045	15.48791504

a. Predictors: (Constant), RNDTOT_XEXPINN

b. Dependent Variable: PRD_XFRMTOT

a) Model Summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2119.171	1	2119.171	8.834	.003[b]
	Residual	39579.460	165	239.876		
	Total	41698.630	166			

a. Dependent Variable: PRD_XFRMTOT

b. Predictors: (Constant), RNDTOT_XEXPINN

b) ANOVA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	23.075	2.989		7.719	.000
	RNDTOT_XEXPINN	.147	.050	.225	2.972	.003

a. Dependent Variable: PRD_XFRMTOT

c) Coefficients

Fig. 5 – Results of testing H2 using linear regression.

From table "Model Summary" (Fig. 5a), R is equal to 0.225, which implies that there is a weak positive correlation between RNDTOT_XEXPINN and PRD_XFRMTOT. R Square is 0.051, indicating that 5.1% of the total variation of the dependent variable (PRD_XFRMTOT) can be explained by the independent variable (RNDTOT_XEXPINN), which is low.

From table "ANOVA" (Fig. 5b), Sig. is equal to 0.003 < 0.05, which is statistically significant.

From table "Coefficients" (Fig. 5c), Sig. for (Constant) is 0.000 < 0.05 and Sig. for RNDTOT_XEXPINN is 0.003 < 0.05, both being statistically significant.

The corresponding econometric equation is:

(2) $\text{PRD_XFRMTOT} = 0.147 * \text{RNDTOT_XEXPINN} + 23.075$

H3: The share of employees from innovative-active firms influences the percentage of firms with business process innovation.

This hypothesis was tested using linear regression and results are shown in Fig. 6. The independent variable is EMP20_INN_XEMP20 and the dependent variable is BPCS_XFRMTOT.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.756[a]	.572	.569	13.72989204

a. Predictors: (Constant), EMP20_INN_OSLO_XEMP20

b. Dependent Variable: BPCS_XFRMTOT

a) Model Summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	41580.065	1	41580.065	220.572	.000[b]
	Residual	31104.139	165	188.510		
	Total	72684.205	166			

a. Dependent Variable: BPCS_XFRMTOT

b. Predictors: (Constant), EMP20_INN_OSLO_XEMP20

b) ANOVA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-5.935	3.779		-1.571	.118
	EMP20_INN_OSLO_XEMP20	.830	.056	.756	14.852	.000

a. Dependent Variable: BPCS_XFRMTOT

c) Coefficients

Fig. 6 – Results of testing H3 using linear regression.

From table "Model Summary" (Fig. 6a), R is equal to 0.756, which implies that there is a strong positive correlation (75.6%) between EMP20_INN_OSLO_XEMP20 and BPCS_XFRMTOT. R Square is 0.572, indicating that 57.2% of the total variation of the dependent variable (BPCS_XFRMTOT) can be explained by the independent variable (EMP20_INN_OSLO_XEMP20), which is high.

From table "ANOVA" (Fig. 6b), Sig. is equal to 0.000 < 0.05, which is statistically significant.

From table "Coefficients" (Fig. 6c), Sig. for (Constant) is 0.119 > 0.05, value that invalidates the constant. Sig. for EMP20_INN_OSLO_XEMP20 is 0.000 < 0.05, being statistically significant.

The corresponding econometric equation is:

(3) $\text{BPCS_XFRMTOT} = 0.83 * \text{EMP20_INN_OSLO_XEMP20}$

H4: The share of employees from innovative-active firms influences the percentage of firms with product innovation.

This hypothesis was tested using linear regression and results are shown in Fig. 7. The independent variable is EMP20_INN_XEMP20 and the dependent variable is PRD_XFRMTOT.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.774[a]	.599	.596	10.07148213

a. Predictors: (Constant), EMP20_INN_OSLO_XEMP20

b. Dependent Variable: PRD_XFRMTOT

a) Model Summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24961.896	1	24961.896	246.088	.000[b]
	Residual	16736.734	165	101.435		
	Total	41698.630	166			

a. Dependent Variable: PRD_XFRMTOT

b. Predictors: (Constant), EMP20_INN_OSLO_XEMP20

b) ANOVA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-10.513	2.772		-3.793	.000
	EMP20_INN_OSLO_XEMP20	.643	.041	.774	15.687	.000

a. Dependent Variable: PRD_XFRMTOT

c) Coefficients

Fig. 7 – Results of testing H4 using linear regression.

From table "Model Summary" (Fig. 7a), R is equal to 0.774, which implies that there is a strong positive correlation (77.4%) between EMP20_INN_OSLO_XEMP20 and BPCS_XFRMTOT. R Square is 0.599, indicating that 59.9% of the total variation of the dependent variable (BPCS_XFRMTOT) can be explained by the independent variable (EMP20_INN_OSLO_XEMP20), which is high.

From table "ANOVA" (Fig. 7b), Sig. is equal to 0.000 < 0.05, which is statistically significant.

From table "Coefficients" (Fig. 7c), Sig. for (Constant) is 0.000 > 0.05, and Sig. for EMP20_INN_OSLO_XEMP20 is 0.000 < 0.05, both being statistically significant.

The corresponding econometric equation is:

(2) $\text{PRD_XFRMTOT} = 0.643 * \text{EMP20_INN_OSLO_XEMP20} - 10.513$

H5: The percentage of firms with business process innovation influences the percentage of turnover of innovative firms out of total turnover.

This hypothesis was tested using linear regression and results are shown in Fig. 8. The independent variable is BPCS_XFRMTOT and the dependent variable is TUR_INN_XTUR20.

From table "Model Summary" (Fig. 8a), R is equal to 0.670, which implies that there is a strong positive correlation (67%) between BPCS_XFRMTOT and TUR_INN_XTUR20. R Square is 0.446, indicating that 44.6 % of the total variation of the dependent variable (TUR_INN_XTUR20) can be explained by the independent variable (BPCS_XFRMTOT), which is less than 50%.

From table "ANOVA" (Fig. 8b), Sig. is equal to 0.000 < 0.05, which is statistically significant.

From table "Coefficients" (Fig. 8c), Sig. for (Constant) is 0.000 > 0.05, and Sig. for BPCS_XFRMTOT is 0.000 < 0.05, both being statistically significant.

The corresponding econometric equation is:

(5) $\text{TUR_INN_XTUR20} = 0.622 * \text{BPCS_XFRMTOT} + 42.665$

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.670[a]	.449	.446	14.44664921

a. Predictors: (Constant), BPCS_XFRMTOT

b. Dependent Variable: TUR_INN_XTUR20

a) Model Summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	28083.734	1	28083.734	134.561	.000[b]
	Residual	34436.436	165	208.706		
	Total	62520.170	166			

a. Dependent Variable: TUR_INN_XTUR20

b. Predictors: (Constant), BPCS_XFRMTOT

b) ANOVA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	42.665	2.801		15.234	.000
	BPCS_XFRMTOT	.622	.054	.670	11.600	.000

a. Dependent Variable: TUR_INN_XTUR20

c) Coefficients

Fig. 8 – Results of testing H5 using linear regression.

H6: The percentage of firms with product innovation influences the percentage of turnover of innovative firms out of total turnover.

This hypothesis was tested using linear regression and results are shown in Fig. 9. The independent variable is PRD_XFRMTOT and the dependent variable is TUR_INN_XTUR20.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.669[a]	.448	.444	14.46682275

a. Predictors: (Constant), PRD_XFRMTOT

b. Dependent Variable: TUR_INN_XTUR20

a) Model Summary

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27987.491	1	27987.491	133.727	.000[b]
	Residual	34532.678	165	209.289		
	Total	62520.170	166			

a. Dependent Variable: TUR_INN_XTUR20

b. Predictors: (Constant), PRD_XFRMTOT

b) ANOVA

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	46.879	2.479		18.913	.000
	PRD_XFRMTOT	.819	.071	.669	11.564	.000

a. Dependent Variable: TUR_INN_XTUR20

c) Coefficients

Fig. 9 – Results of testing RH1 using linear regression.

From table "Model Summary" (Fig. 9a), R is equal to 0.669, which implies that there is a strong positive correlation (66.9%) between PRD_XFRMTOT and TUR_INN_XTUR20. R Square is 0.448, indicating that 44.8% of the total variation of the dependent variable (TUR_INN_XTUR20) can be explained by the independent variable (PRD_XFRMTOT), which is less than 50%.

From table "ANOVA" (Fig. 9b), Sig. is equal to 0.000 < 0.05, which is statistically significant.

From table "Coefficients" (Fig. 9c), Sig. for (Constant) is 0.000 > 0.05, and Sig. for PRD_XFRMTOT is 0.000 < 0.05, both being statistically significant.

The corresponding econometric equation is:

(6) $\text{TUR_INN_XTUR20} = 0.819 * \text{PRD_XFRMTOT} + 46.879$

5. Conclusion

This research investigated innovation in the countries using the guidelines from the Oslo manual (OECD & Eurostat, 2018) in measuring innovation. It focused on the following research questions:

RQ1. Do R&D expenditures influence innovation?

RQ2. Does the share of employees influence innovation?

RQ3. Does innovation influence turnover of companies?

To answer these research questions, his study used the dataset "the 2023 edition of the innovation indicators" (OECD, 2023a) published by OECD. The data was analysed using statistical methods, by testing the following hypotheses:

H1. The percentage of R&D expenditures out of total expenditures on innovation activities influences the percentage of firms with business process innovation.

H2. The percentage of R&D expenditures out of total expenditures on innovation activities influences the percentage of firms with product innovation.

H3. The share of employees from innovative-active firms influences the percentage of firms with business process innovation.

H4. The share of employees from innovative-active firms influences the percentage of firms with product innovation.

H5. The percentage of firms with business process innovation influences the percentage of turnover of innovative firms out of total turnover.

H6. The percentage of firms with product innovation influences the percentage of turnover of innovative firms out of total turnover.

As a result, the first two hypotheses (H1, H2) show a very weak correlation between R&D expenditures and business process innovation, respectively product innovation. This result is surprising, contradicting scientific

literature that considers R&D as a major determinant of innovation, while agreeing with scientific literature stating that innovation can come from outside R&D. One potential explanation for this result might come from the variables used. While RNDTOT_XEXPINN refers only to companies with innovation, BPCS_XFRMTOT and PRD_SERV_XFRMTOT are a percentage of total companies, which includes innovative and non-innovative firms. This can be further clarified in a future research.

The next two hypotheses (H3, H4) align with the scientific literature. The number of employees in innovative firms influences the percentage of business process innovative firms and product innovative firms. It also brings a contribution to scientific literature by having tested these hypotheses for the countries in Table 2.

The last two hypotheses (H5, H6) confirm that innovation influences turnover of the companies. This confirms the existing scientific literature. It also brings a contribution to scientific literature by having tested these hypotheses for the countries in Table 2.

Besides the contributions to theory, this research is also valuable to managers. To increase turnover of their company, managers should increase innovation in their firms. To do this, they will need to increase the number of employees. However, the last statement should be further researched by taking into consideration additional variables which might influence innovation to properly analyse the complex and intertwined factors influencing innovation nowadays. An example of such variable might be digital technologies, for example artificial intelligence.

This research also has its own limitations. Firstly, it focuses only on 29 countries out of the 42 countries that have applied the guidelines in the Oslo Manual, due to only these countries having complete data available. Thus, the findings cannot be generalized to all 42 countries. Secondly, it analysed only the data for total R&D, as explained in Section 4. It would be interesting to explore whether the same results are obtained when analysing the data corresponding to "No R&D" or "R&D". Thirdly, it uses linear regression for testing all the hypotheses even though only two (out of the five variables) from the model have a normal distribution, which might raise issues regarding the generalisability of the results obtained.

There are also several research directions for future studies. Firstly, studies could focus on analysing other variables that influence the percentage of business process or product innovative firms within the 42 countries. This might be done even by using the same dataset, while focusing on other variables than the 6 in focus in this study out of the 47 variables available. Secondly, the dataset used in this study was for 2018 – 2020. A more recent dataset (2021 – 2026) should be analysed by future studies, but such a dataset was unavailable at the time when this research was conducted.

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INOVARE: CERCETĂRI ASUPRA VARIABILELOR CARE INFLUENȚEAZĂ INOVAREA DE PROCES ȘI DE PRODUS

(Rezumat)

Inovarea a devenit o necesitate pentru companii pentru a-și îmbunătăți reziliența organizațională, pentru a-și crește performanța financiară și pentru a răspunde la provocările venite din exterior. Inovarea reprezintă procesul prin care se generează inovație. În funcție de tipul obiectului care este inovat, inovația poate fi împărțită în două categorii: de proces și de produs. O inovație de produs poate conduce la nevoia de a inova și un proces, astfel încât cele două tipuri se pot regăsi combinate în practică, fiind greu de delimitat una de cealaltă. Inovarea conduce la creștere economică. Prin urmare, atât companiile, cât și țările își doresc să genereze cât mai multă inovație, stimulând acest lucru prin politici, activități și finanțare. Pentru a se asigura că acțiunile lor își îndeplinesc scopul, acestea sunt nevoite să măsoare inovarea. Organizația pentru Cooperare și Dezvoltare Economică (OECD) și Eurostat oferă o abordarea standardizată pentru a evalua inovarea la nivelul organizațiilor și a țărilor, facilitând nu doar măsurarea, ci și analiza comparativă între entități. Această abordare implică un chestionar standardizat, care este aplicat în mai mult de 80 de țări și este îmbunătățit recurent pe baza feedbackului obținut. Rezultatele acestui chestionar, aplicat de mai multe țări, au fost publicate de OECD și reprezintă datele folosite în acest studiu. Folosind o abordare cantitativă, cercetarea explorează variabilele care influențează inovarea de proces și de produs. Sunt formulate mai multe ipoteze care sunt testate prin metode statistice. În primul rând, studiul analizează dacă cheltuielile în cercetare-dezvoltare influențează inovarea de proces (H1), respectiv inovarea de produs (H2). Ipotezele H1 și H2 sunt invalidate prin metode statistice. În al doilea rând, cercetarea investighează dacă procentajul de angajați în firme cu inovare, din totalul angajaților din 2020, influențează inovarea de proces (H3), respectiv inovarea de produs (H4). Ambele ipoteze (H3, H4) sunt validate statistic, constatându-se o influență pozitivă. În al treilea rând, studiul demonstrează că cifra de afaceri este influențată de inovarea de proces (H5), respectiv de produs (H6). Ipotezele H5 și H6 sunt validate statistic. Rezultatele acestei cercetării contribuie la literatura

științifică, prin demonstrarea relațiilor dintre inovarea de proces, inovarea de produs, cheltuieli în C&D, procentajul de angajați și cifra de afaceri. Acesta oferă și recomandări pentru managerii care doresc să-și crească inovarea și cifra de afaceri.