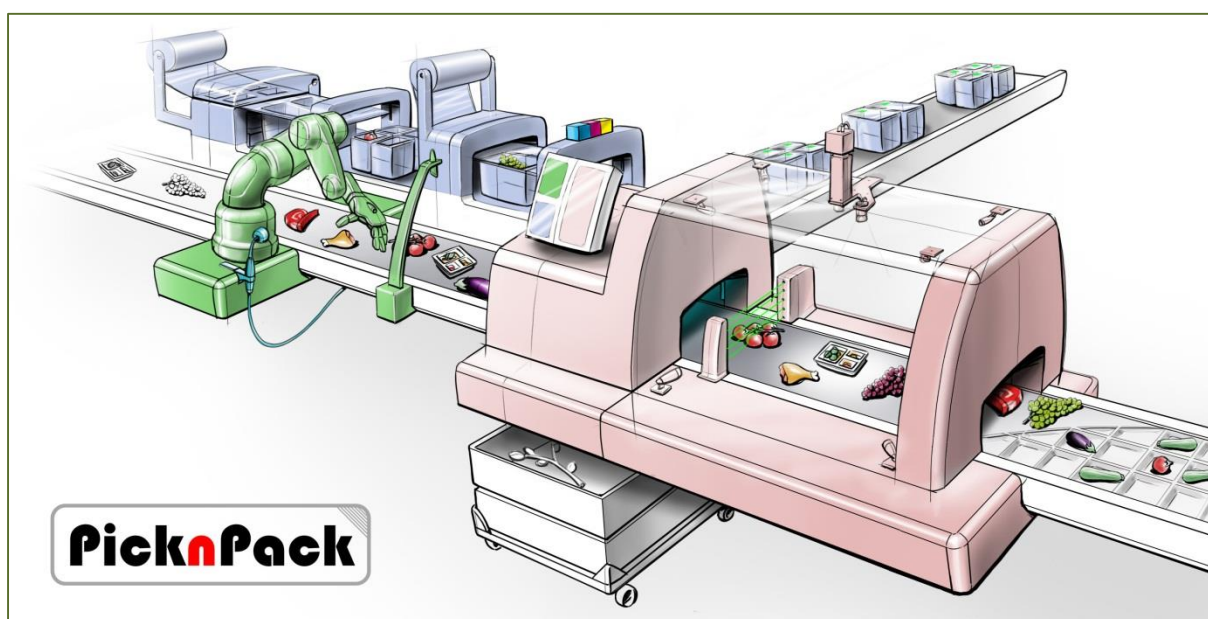


# D9.3 – Social evaluation report for manual and automated packaging of fresh food and ready-to-eat products

## WP9 – Life cycle analysis and sustainability

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Flexible robotic systems for automated adaptive packaging of fresh and processed food products

Dissemination level		
PU	Public	X
PR	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC Services)	



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## 1 Executive summary

This report aims to assessment of the social impact of the PicknPack project (hereinafter abbreviated as PnP). In order to achieve this goal, a social evaluation based in hotspots was carried out. In this sense, three social hotspots were evaluated: (1) human resources, (2) productivity of the employees and (3) expectations on the of qualification of the employees. This assessment allows the identification the opportunities created with the new technology developed by PnP project.

The social evaluation shows that the introduction of the PnP line in the food industries will have positive effects, increasing the competitiveness of the European industry. PnP line reduces the labour cost because of the less number of working staff while increases the quality of jobs positions in comparison to the qualification required in conventional packaging lines. Additionally, the flexibility in processing reduces the dead times for chaning of products and increases the labour productivity up to 75%.

## 2 Introduction

All over the world, companies make business decisions every day which affect people and environment, directly through their own operations, or indirectly through the value chain of their business. Nowadays, consumers are quering on the impacts (environmental, economic and social) of the products. In order to answer to these growing queries, companies are recognizing the urgency to conduct business in a socially manner, because in an other way, It would mean an ill image for their companies and considerable losses.

To assist food packaging industry in fulfilling these tasks, systematic analytical tools have been developed. In PnP we have been carried out an environmental LCA, economic LCA and Eco- efficiency assess and finally, social evaluation which their outcomes are summarized in this report. All of those assessments take part of the PicknPack project.

The social evaluation has followed the hotspots<sup>1</sup> assessment. Hotsopts assessment provides additional information on where the issues of concern may be the most significant in the packaging line operations. In this case, the approach of the hotspots have been positive, which means, the identification of the opportunities created by PnP line implementation.

Three main categories were identified as social hotspots for the subsequent evaluation: (1) human resources, (2) productivity of the employees and (3) excepctation of qualification of the employees.

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<sup>1</sup> Social Hotspots: Are unit processes located in a region where the situation occurs that may be considered a problem, a risk or an opportunity, in relation to a social theme of interest.

## 2. Method for social evaluation

### 2.1 Social indicators

The assessment of the social impacts of the PicknPack line has been considered from the point of view of the influence that an automated plant may have in the labour conditions because of the implementation of a new flexible and automated packaging line like PnP.

The full list of social indicators analysed is listed in Table 1. These indicators were referred to the above mentioned categories of social hotspots: (1) human resources required for the packaging line operation, (2) productivity of the employees and (3) the expected level of qualification of the employees. The social indicators analysed were directly related those already collected in PnP WP12 (Olabarrieta et al., 2016).

*Table 1 – List of social indicators analysed within PnP social evaluation*

Social indicator	Type of indicator	Description	Metrics
<b>Saving in labour cost</b>	Human resources required	Difference in labour cost between PnP and food industries	€
<b>Flexibility of the equipment for different operations in the processing plant</b>	Human resources required	Time spent to change package format	h
<b>Staff reduction</b>	Human resources required	Difference in number of employees between PnP and food industries	Nº employees
<b>Labour productivity</b>	Productivity of the employees	Profit generated per hour of work	€/h
<b>Individual employee contribution</b>	Productivity of the employees	Amount of money produced for the company by employee, in a certain time period	€/employees
<b>Quality of jobs positions</b>	Qualification of the employees	Proportion of qualified employment	%

## 2.2 Human resources required for the packaging line operation

Human resources required for the packaging line operation was assessed combining the social indicators saving labour cost, flexibility of the equipment for different operations in the processing plant and staff reduction. The formulas for calculations are described below.

### 2.2.1 Saving labour cost

Saving labour cost was the quantity of money that the enterprises will save in labour cost if they introduce the PnP line in their processes. It could be calculated with a simple equation:

$$\text{Saving Labour Cost (€)} = \text{Labour cost using a conventional line (€)} - \text{Labour cost using PnP line (€)}$$

The labour cost data for conventional and PnP line were taken from the life cost analysis of the PnP project (more details in provided in PnP Deliverable 9.2 on LCC). The estimated savings are presented in Table 2.

*Table 2 – Estimated savings on labour cost (in €) for the different conventional packaging format and machines compared to PnP line. A positive value means a saving in relation to the PnP counterpart.*

Saving labour cost							
Fruits and vegetables					Ready meals		
Format	160x120x75	180x120x75	240x120x75	240x160x75	160x120x35	180x120x35	240x120x35
Packed ID	1	2	3	4	5	6	7
Mach.	A-1	A-2	A-3	A-4	---		
NL	148.81	132.19	99.22	74.43			
UK	109.61	97.37	73.09	54.82			
SP	104.89	93.18	69.94	52.46			
Mach.	B-1	B-2	B-3	B-4			
NL	148.81	132.19	99.22	74.43			
UK	109.61	97.37	73.09	54.82			
SP	104.89	93.18	69.94	52.46			
Mach.	---				C-5	C-6	C-7
NL					155.21	137.50	103.23
UK					114.33	101.28	76.04
SP					109.41	96.92	72.77
Mach.					D-5	D-6	D-7
NL					155.21	137.50	103.23
UK					114.33	101.28	76.04
SP					109.41	96.92	72.77
Mach.					E-5	E-6	E-7
NL					155.21	137.50	103.23
UK					106.13	101.28	76.04
SP					109.41	96.92	72.77

In accordance with the data from the table, for each format of package and for each machine, labour cost saving are higher in Netherlands, followed by the UK and Spain, respectively. That behaviour, is related to labour cost. Countries with higher salary like The Netherlands, shows higher saving when the PnP line was implemented in their facilities because of the reduction of number of working staff for the operation of the packaging line.

For both the fruit & vegetables and ready meals lines, an increase of the size of the package results in less labour cost savings. This is because the weight of the labour cost per unit of package related to the total cost.

### 2.2.2 Flexibility in processing

Flexibility of the equipment for different operations in the processing plant was calculated as the time that was needed to change from one package format to other. The value could be calculated with a simple equation:

$$\begin{aligned} \text{Flexibility in processing (h)} &= \text{Time needed to changing packaging formats in a conventional line (h)} \\ &- \text{Time needed to changing packaging formats in a PnP line(h)} \end{aligned}$$

ITENE's experts considered that the average time needed for changing the the moulds in a conventional thermoforming line was around 1.25 h, while in the PnP line this time decreases up to 0.25 h, in accordance with the tests made in PnP with the modular mould system based on bricks. Table 3 shows the time saved related with the flexibility in processing and also the cost associated to this less flexibility in each one of the machines in comparison with the PnP line.

*Table 3 – Estimated time (in h) and cost saved (€) related with flexibility in processing in relation to the PnP counterpart. A positive value means a saving.*

Flexibility in processing								
Format		160x120 x75	180x120 x75	240x120 x75	240x160 x75	160x120 x35	180x120 x35	240x120 x35
Packed ID		1	2	3	4	5	6	7
Machine		A-1	A-2	A-3	A-4	---		
Time reduced (h)	NL	1	1	1	1			
Cost of 1 h of production (€)	NL	865	970	1207	1476			
Time reduced (h)	UK	1	1	1	1			
Cost of 1 h of production (€)	UK	798	903	1141	1410			
Time reduced (h)	SP	1	1	1	1			
Cost of 1 h of production (€)	SP	764	866	1094	1350			
Machine		B-1	B-2	B-3	B-4			

Flexibility in processing								
Format		160x120 x75	180x120 x75	240x120 x75	240x160 x75	160x120 x35	180x120 x35	240x120 x35
Time reduced (h)	NL	1	1	1	1			
Cost of 1 h of production (€)	NL	858	979	1240	1420			
Time reduced (h)	UK	1	1	1	1			
Cost of 1 h of production (€)	UK	791	912	1173	1354			
Time reduced (h)	SP	1	1	1	1			
Cost of 1 h of production (€)	SP	757	875	1126	1294			
Machine		---				C-5	C-6	C-7
Time reduced (h)	NL					1	1	1
Cost of 1 h of production (€)	NL					5303	5959	7729
Time reduced (h)	UK					1	1	1
Cost of 1 h of production (€)	UK					5204	5861	7632
Time reduced (h)	SP					1	1	1
Cost of 1 h of production (€)	SP					5191	5848	7619
Machine						D-5	D-6	D-7
Time reduced (h)	NL					1	1	1
Cost of 1 h of production (€)	NL					5247	5856	7669
Time reduced (h)	UK					1	1	1
Cost of 1 h of production (€)	UK					5149	5758	7573
Time reduced (h)	SP					1	1	1
Cost of 1 h of production (€)	SP					5136	5745	7559
Machine						E-5	E-6	E-7
Time reduced (h)	NL					1	1	1
Cost of 1 h of production (€)	NL					5216	5839	7647
Time reduced (h)	UK					1	1	1
Cost of 1 h of production (€)	UK					5118	5741	7551



Format		Flexibility in processing						
		160x120 x75	180x120 x75	240x120 x75	240x160 x75	160x120 x35	180x120 x35	240x120 x35
Time reduced (h)	SP					1	1	1
Cost of 1 h of production (€)	SP					5105	5728	7537

The results showed that the PnP line allows to save 1 in comparison to the conventional packing lines. The estimated cost saved with PnP lines ranges between 700 and 1300 € for the fruit and vegetables line, while for ready meals these savings are much higher, being in a range between 5000 and 8000 €. The reason was the higher selling price of the ready meal units.

It is also worth to note that the cost there is a direct proportion with the size of the package (the higher size the bigger saving) because the net benefit from each sale was also higher.

### 2.2.3 Staff reduction

Staff reduction refers to the difference between number of employees that was necessary to manage a conventional line and the number of employees that can manage the whole PnP line. In order to get this value, it was could be used a simple calculation as the following below:

$$\text{Staff reduction (\%)} = 100 - \left( \frac{N^{\circ} \text{ employees needed in a PnP line}}{N^{\circ} \text{ employees needed in a conventional line}} * 100 \right)$$

The social targets related to human resources use, were evaluated considering the average number of workers operating a packaging machinery within the food industry. The number workers were taken from the observations made within the five companies operating a conventional thermoformer line in Spain as well as the packaging lines for tomatoes and chicken products visited in The Netherlands and Spain, respectively (Table 5).

In the specific case of the tomatoes processing plant in The Netherlands, the company considers that 12 to 10 employees were required per shift as function of the season (summer or winter, respectively).

By combining all the data, then the average calculated number of workers was in the range of 10 workers working in 2 shifts. This number of employees was sound with the current staff required for the operation of a food packaging line, “where 20 different jobs are run on a typical day” in accordance with Higgins (2016). Considering that the food packaging industry operates usually in two shifts a day (day and night), then, it could be concluded that then 10 employees were required on average for the operation of a conventional thermoforming/packaging line.

On the other hand, the number of estimated workers for the PicknPack line was consulted informally to WP7 during the visit made to Wageningen in March 2016 for the power consumption measurement of the different modules. This was confirmed also with the analogy made for the LCA system boundaries between the manual vs automated operations in PnP line and the conventional



thermoforming/packaging lines, in accordance with the outcomes from the visit to the tomatoes packaging plant in The Netherlands. Table 4 shows the analogy made for the operations which does not require of further staff because of the automated operation of the PnP line.

*Table 4 – Analogy of automated and manual steps in a food packaging operation with the PnP line and conventional thermoforming/packaging lines*

Step	PnP line		Conventional line	
	Operation mode	Estimated number of employees	Operation mode	Estimated number of employees*
Crates supply	Manual	2	Manual	2
Food supply from crates to the packaging line	Automated	0	Automated	0
Picking of the product	Automated	0	Manual	2
Quality control	Automated	1	Manual	2
Printing, cutting and sealing	Automated	0	Automated	0
PicknPlace of packaging units	Automated	0	Manual	2
Cleaning	Automated	0	Manual	1
Moving crates with packaged units to the Factory gate	Manual	1	Manual	1
Estimated total	---	4	---	10

\* The difference between the 10 employees estimated for the PnP line and the chicken-based ready meals packaging line visited in Navarre (Spain) can be explained for the strict rules of quality control and hygiene that apply to these kind of products (Table 5). It has been found that at least 2 additional employees are required in the steps of picking, placing of packaging units and in cleaning operation as well. For quality control, a couple of additional employees are required in order to verify the quality of the three ingredients (poultry meat, carrot & beans, potatoes). Therefore, this results in a requirement of 17 employees in the company visited.

*Table 5 – Estimated average number of workers in accordance with the observations made during the visits to the companies operating conventional thermoforming and packaging lines consulted in PicknPack LCA.*

Machine ID	Location	Activity	Packaging material	Packaging dimensions (mm)	Packaging thickness (mm)	Number of workers operating the equipment and related operations by shift (cleaning, maintenance, control, etc.)
A	Alicante, Spain	Production of thermoformed packaging	PVC	280x95x20	0.194	6
B	Valencia, Spain	Production of thermoformed packaging	A-PET	150x100x20	0.2	8
C	Valencia, Spain	Production of thermoformed packaging	PP	180x250x80	0.76	9
D	Valencia, Spain	Production of thermoformed packaging	PP	200x300x65	0.825	9
E	Murcia, Spain	Production of thermoformed packaging	PET	255x153x38	0.49	9
N/A	Navarre, Spain	Packaging of chicken-based foodstuff	A-PET	Only packaging operations		17*
				Quantitative data available		
N/A	Zuid Holland, The Netherlands	Packaging of tomatoes	Plastic and paper-based packaging	Only packaging operations		12 (summer season)
				Only qualitative data available		10 (winter season)
Estimated average number of workers						10

\*The high number of employees in is explained because of the very strict of quality control and hygiene that apply to these kind of products.

Table 6 summarizes the staff reduction between the number of employees working in a conventional line and the employees at PnP line.

*Table 6 – Estimated staff reduction because of the automated operation of the PnP line.*

Number of workers operating a conventional line	Number of employees working at PnP line	Staff reduction (%)
10	4	60

Therefore, the introduction of PnP line in the food industry companies could results in a reduction of the number of employees of about 6 workers, which is more than 50% of the initial staff.

### 2.3 Productivity of the employees

The productivity of the employees was assessed combining the expected level of production calculated in the previous Deliverable 9.1 of PicknPack project. The formulas for calculation were taken from Esposito (2015). The employee productivity had a huge impact on profits, and could be calculated with a very simple equation of labour productivity:

$$\text{Labour productivity} \left( \frac{\text{€}}{h} \right) = \frac{\text{Total output (€)}}{\text{Total input (h)}}$$

The labour productivity means the value generated at the company per hour of work (Esposito, 2015)

It was possible also to look at labour productivity in terms of individual employee contribution. In this case, the number of employees would be used instead the hours of working:

$$\text{Individual employee contribution} \left( \frac{\text{€}}{p} \right) = \frac{\text{Total output (€)}}{\text{Number of employees (p)}}$$

The individual employee contribution represented the amount of money produced for the company by employee, in a certain time period (day, week, month, year, etc.).

The above-mentioned parameters were calculated for both the PnP case and conventional thermoforming/packaging equipment. Even though such indicators had their own units, for the social evaluation the percentage of change becomes important than the absolute value, as this demonstrates the difference between the compared systems.

Data like amount of product ready to be sold or cost per ton of product was gathered from the PnP Deliverable 9.2 on LCC.

Additionally, a common scenario of sales was developed for a consistent comparison of the results. For the fruit and vegetables line, it was assumed that the products were sold in France. This was considered because of the equal distance between The Netherlands, UK and Spain, were the packaging units of tomatoes were produced.



However, for the ready meals line we were unable to find average prices for the ready meals prices in France. Thus, the target market selected was Spain where prices of different ready meals were got it from the Carrefour database. The results all these calculations are shown in Table 7.

Table 7 – Results from the calculation of productivity of the employees of PnP and conventional thermoforming/packaging lines for fruits and vegetables (based on the outcomes of D9.1 and D9.2 of PnP project). The basis for calculation (or functional unit) was established as a work shift of 8 h.

Application	Fruit & vegetables											
Material type	APET											
Packaging format size (mm)	160x120x75			180x120x75			240x120x75			240x160x75		
Packaging format ID	1			2			3			4		
MACHINE A	A-1			A-2			A-3			A-4		
Packages ready to be sold produced in a shift of 8h (u)	12,384			12,384			12,384			12,384		
Amount of product ready to be sold produced in a shift of 8h (t)	4.33			4.88			6.50			8.67		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES	NL	UK	ES
Cost per ton of product (€/t)	1,596	1,473	1,410	1,590	1,480	1,419	1,485	1,403	1,346	1,362	1,301	1,246
Cost of 8h (€)	6,917	6,384	6,112	7,756	7,224	6,926	9,656	9,125	8,749	11,808	11,278	10,798
Market price of tomatoes in France in €/kg	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
Incomes from sellings of product in a 8h shift (€)	10,012	10,012	10,012	11,271	11,271	11,271	15,019	15,019	15,019	20,025	20,025	20,025
Net benefit	3,095	3,628	3,900	3,515	4,047	4,346	5,362	5,894	6,270	8,217	8,747	9,227
Number of employees (p)	10	10	10	10	10	10	10	10	10	10	10	10
Total number of hours to produce the goods (h)	80	80	80	80	80	80	80	80	80	80	80	80
Labour productivity (€/h)	38.69	45.35	48.75	43.94	50.59	54.32	67.03	73.67	78.37	102.71	109.33	115.33
Individual employee contribution (€/p)	309.52	362.83	390.02	351.49	404.75	434.55	536.23	589.38	626.97	821.65	874.66	922.66
MACHINE B	B-1			B-2			B-3			B-4		
Packages ready to be sold produced in a shift of 8h (u)	12,384			12,384			12,384			12,384		
Amount of product ready to be sold produced in a shift of 8h (t)	4.33			4.88			6.50			8.67		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES	NL	UK	ES



Application	Fruit & vegetables											
Cost per ton of product (€/t)	1,583	1,460	1,397	1,605	1,496	1,435	1,525	1,444	1,386	1,311	1,249	1,194
Cost of 8h (€)	6,862	6,329	6,057	7,830	7,298	7,000	9,916	9,387	9,010	11,361	10,831	10,351
Market price of tomatoes in France in €/kg	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
Incomes from sellings of product in a 8h shift (€)	10,012	10,012	10,012	11,271	11,271	11,271	15,019	15,019	15,019	20,025	20,025	20,025
Net benefit	3,151	3,683	3,955	3,441	3,973	4,271	5,103	5,632	6,009	8,664	9,194	9,674
Number of employees (p)	10	10	10	10	10	10	10	10	10	10	10	10
Total number of hours to produce the goods (h)	80	80	80	80	80	80	80	80	80	80	80	80
Labour productivity (€/h)	39.39	46.04	49.44	43.02	49.66	53.39	63.78	70.40	75.11	108.30	114.92	120.92
Individual employee contribution (€/p)	315.08	368.34	395.55	344.12	397.28	427.13	510.25	563.18	600.87	866.43	919.36	967.39
MACHINE P1	P1-1			P1-2			P1-3			P1-4		
Packages ready to be sold produced in a shift of 8h (u)	12,384			12,384			12,384			12,384		
Amount of product ready to be sold produced in a shift of 8h (t)	4.33			4.88			6.50			8.67		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES	NL	UK	ES
Cost per ton of product (€/t)	1,120	1,076	1,020	1,590	1,480	1,419	1,485	1,403	1,346	1,362	1,301	1,246
Cost of 8h (€)	4,852	4,666	4,422	7,756	7,224	6,926	9,656	9,125	8,749	11,808	11,278	10,798
Market price of tomatoes in France in €/kg	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
Incomes from sellings of product in a 8h shift (€)	10,012	10,012	10,012	11,271	11,271	11,271	15,019	15,019	15,019	20,025	20,025	20,025
Net benefit	5,160	5,347	5,590	3,515	4,047	4,346	5,362	5,894	6,270	8,217	8,747	9,227
Number of employees (p)	4	4	4	4	4	4	4	4	4	4	4	4
Total number of hours to produce the goods (h)	32	32	32	32	32	32	32	32	32	32	32	32
Labour productivity (€/h)	161.25	167.09	174.69	109.84	126.48	135.80	167.57	184.18	195.93	256.77	273.33	288.33
Individual employee contribution (€/p)	1,290	1,337	1,398	879	1,012	1,086	1,341	1,473	1,567	2,054	2,187	2,307

Table 8 – Results from the calculation of productivity of the employees of PnP and conventional thermoforming/packaging lines for ready-meals (based on the outcomes of D9.1 and D9.2 of PnP project). The basis for calculation (or functional unit) was established as a work shift of 8 h.

Application	Ready meals								
Material type	PP								
Packaging format size (mm)	160x120x35			180x120x35			240x120x35		
Packaging format ID	5			6			7		
MACHINE C	C-5			C-6			C-7		
Packages ready to be sold produced in a shift of 8h (u)	18,576			18,576			18,576		
Amount of product ready to be sold produced in a shift of 8h (t)	6.23			7.04			9.37		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES
Cost per ton of product (€/t)	6,805	6,678	6,662	6,774	6,663	6,648	6,599	6,516	6,505
Cost of 8h (€)	42,421	41,634	41,530	47,673	46,892	46,785	61,834	61,058	60,949
Market price of ready meal in Spain in €/kg	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56
Incomes from sellings of product in a 8h shift (€)	72,066	72,066	72,066	81,351	81,351	81,351	108,321	108,321	108,321
Net benefit	29,645	30,432	30,536	33,678	34,459	34,566	46,487	47,263	47,371
Number of employees (p)	10	10	10	10	10	10	10	10	10
Total number of hours to produce the goods (h)	80	80	80	80	80	80	80	80	80
Labour productivity (€/h)	370.57	380.40	381.70	420.98	430.74	432.07	581.08	590.79	592.14
Individual employee contribution (€/p)	2,965	3,043	3,054	3,368	3,446	3,457	4,649	4,726	4,737
MACHINE D	D-5			D-6			D-7		
Packages ready to be sold produced in a shift of 8h (u)	18,576.00			18,576.00			18,576.00		
Amount of product ready to be sold produced in a shift of 8h (t)	6.23			7.04			9.37		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES
Cost per ton of product (€/t)	6,733	6,607	6,591	6,657	6,546	6,531	6,548	6,465	6,454
Cost of 8h (€)	41,977	41,191	41,087	46,848	46,063	45,958	61,355	60,581	60,472
Market price of ready meal in Spain in €/kg	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56



Application	Ready meals								
Incomes from sellings of product in a 8h shift (€)	72,066	72,066	72,066	81,351	81,351	81,351	108,321	108,321	108,321
Net benefit	30,089	30,875	30,979	34,503	35,288	35,393	46,965	47,740	47,849
Number of employees (p)	10	10	10	10	10	10	10	10	10
Total number of hours to produce the goods (h)	80	80	80	80	80	80	80	80	80
Labour productivity (€/h)	376.11	385.94	387.24	431.29	441.10	442.41	587.07	596.74	598.11
Individual employee contribution (€/p)	3,009	3,088	3,098	3,450	3,529	3,539	4,697	4,774	4,785
MACHINE E	E-5			E-6			E-7		
Packages ready to be sold produced in a shift of 8h (u)	18,576			18,576			18,576		
Amount of product ready to be sold produced in a shift of 8h (t)	6.23			7.04			9.37		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES
Cost per ton of product (€/t)	6,694	6,568	6,551	6,637	6,526	6,511	6,529	6,447	6,435
Cost of 8h (€)	41,732	40,944	40,840	46,709	45,926	45,820	61,179	60,410	60,298
Market price of ready meal in Spain in €/kg	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56
Incomes from sellings of product in a 8h shift (€)	72,066	72,066	72,066	81,351	81,351	81,351	108,321	108,321	108,321
Net benefit	30,335	31,123	31,226	34,642	35,426	35,531	47,142	47,911	48,023
Number of employees (p)	10	10	10	10	10	10	10	10	10
Total number of hours to produce the goods (h)	80	80	80	80	80	80	80	80	80
Labour productivity (€/h)	379.18	389.03	390.32	433.02	442.82	444.14	589.28	598.88	600.28
Individual employee contribution (€/p)	3,033	3,112	3,123	3,464	3,543	3,553	4,714	4,791	4,802
MACHINE P2	P2-5			P2-6			P2-7		
Packages ready to be sold produced in a shift of 8h (u)	12,384			12,384			12,384		
Amount of product ready to be sold produced in a shift of 8h (t)	4.16			4.69			6.25		
Scenario	NL	UK	ES	NL	UK	ES	NL	UK	ES
Cost per ton of product (€/t)	6,398	6,353	6,344	6,379	6,339	6,332	6,327	6,297	6,291
Cost of 8h (€)	26,589	26,402	26,365	29,932	29,745	29,708	39,524	39,337	39,300
Market price of ready meal in Spain in €/kg	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56	11.56



Application	Ready meals								
Incomes from sellings of product in a 8h shift (€)	48,043	48,043	48,043	54,240	54,240	54,240	72,215	72,215	72,215
Net benefit	21,455	21,642	21,678	24,308	24,495	24,531	32,692	32,878	32,915
Number of employees (p)	4	4	4	4	4	4	4	4	4
Total number of hours to produce the goods (h)	32	32	32	32	32	32	32	32	32
Labour productivity (€/h)	670.46	676.30	677.45	759.62	765.46	766.61	1,021.61	1,027.45	1,028.60
Individual employee contribution (€/p)	5,364	5,410	5,420	6,077	6,124	6,133	8,173	8,220	8,229

Firstly, the results had shown that for a common market, the labour productivity was lower in the Countries where the production cost was higher due to the higher price of raw materials, electricity or salaries. Consequently, the best Country to produce packing units is Spain, followed by United Kingdom and Netherlands.

Another clear trend was associated with the size of the packages. The labour productivity increases with the size of the packages produced. It could be explained by the increase of product (either tomatoes or ready meals) sold at the end of a work shift of 8 h.

On the other hand, when compared the labour productivity between conventional lines and PnP line, the PnP line presents a remarkable increase in labour productivity. For fruits and vegetables an increase between 75% to 58% was reached for smallest and biggest package, respectively. In the case of ready meals, such increase was 43% and 41%.

Related with individual employee contribution, similar trends were found.

## 2.4 Quality of jobs positions

Quality of jobs positions was related with the education level required to apply to the job position. In this case, two different categories were described. The first one was a production staff for which no special training was required, while the second one was related with technical staff which requires specific training. The social indicator could be calculated with a simple equation:

$$\text{Quality of job positions (\%)} = \frac{\text{Job positions for technical staff (n}^{\circ}\text{)}}{\text{Total job positions (n}^{\circ}\text{)}} * 100$$

For conventional lines of 10 workers, it was considered that 2 of them had special training in mechatronics and other in quality. The remaining people were related with production staff. On the other hand, in PnP line where just needed 4 workers, it was considered that 2 technical staff were required in order to check and control the new line. The other 2 jobs positions fed the line with raw material, plastic, fruits, vegetables and ready meals ingredients. Table 9 summarizes the rate of specialized technical staff in relation to the total job positions. Additionally the quality of the jobs positions is increased by 30% because of the higher qualification required.

*Table 9 – Estimated increase of quality of job positions because of the automated concept machinery of the PnP line*

Proportion of technical staff - conventional line (%)	Proportion of technical staff - PnP line (%)	Increase of quality of job positions (%)
20	50	30

These results have a positive social impact because means the return of the investment that the government done it in specialized training and education.

### 3 Conclusions and recommendations

Looking at the social results obtained, it can be concluded that:

- The introduction of the PnP line in the food industry reduces the labour cost in an average of 100 €/t produced.
- The enhanced flexibility in processing provided by the PnP technology, allows to reduce in 1 hour the time needed to change the product to be packaged. Such cost saving is related with the dead time where the line is not producing.
- PnP technology reduces the number of workers by 60% compared to the conventional packaging lines.
- Labour productivity could be potentially increased up to 75% if the PnP line is introduced in food industries.
- PnP technology could potentially improve the quality of job positions by a 30% when compared to conventional packaging lines.

### 4 References

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