Method Article

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Refining ROI calculation for end-of-line automation in a food factory: avoiding common mistakes and oversights

Abstract

End-of-line automation offers numerous benefits for industries, including improved efficiency, cost reduction, and enhanced product quality. However, accurately calculating the return on investment (ROI) is crucial for businesses considering automation. This article explores common mistakes made during ROI assessments for end-of-line automation and provides insights on how to avoid them. The article presents detailed calculations for different countries, including France, the USA, Saudi Arabia, and India, taking into account factors such as running costs, maintenance, and potential ramp-up periods. The analysis reveals the impact of these factors on ROI and emphasizes the need for comprehensive evaluations when making informed decisions about automation investments. The article concludes by highlighting the importance of considering all relevant factors and the quality of robots themselves in determining accurate ROI assessments for end-of-line automation.

Volume 11 Issue 2 - 2023

Muhammad Mubashar
Maintenance Manager for Saudi Arabia factories, Pladis global, Saudi Arabia

Correspondence: Muhammad Mubashar, Maintenance Manager for Saudi Arabia factories, Pladis global, Saudi Arabia, Tel +966532499882, Email muh.mbsh@gmail.com

Received: July 09, 2023 | **Published:** July 19, 2023

Introduction

End-of-line automation has become increasingly prevalent in industries across the globe, offering numerous benefits such as improved efficiency, reduced costs, and enhanced product quality[1]. However, to determine the true value of implementing such automation, businesses must accurately calculate the return on investment (ROI[2]). Unfortunately, many organizations make several common mistakes when assessing the ROI of end-of-line automation. In this article, we will discuss these mistakes and provide insights on how to avoid them, enabling businesses to make informed decisions about automation investments.

Neglecting the cost of running

Businesses normally miss considering that adding end-of-line automation means adding new very complex machinery in the plant which would not only consume electricity and other utilities like compressed air, cooling water, etc. but would also cause downtime on the line, in terms of machine breakdowns and short stops which waste labor ours which might not be there in case of manual labor. These downtimes might not be very significant, but the cost of electricity might be a major factor in decision-making if considered, especially in countries where the cost of electricity[3] is high in comparison to manual labor like India, etc.

Ignoring potential ramp-up periods

Transitioning from manual processes to automated systems may involve downtime and a ramp-up period[4] for employees to adapt. Companies often underestimate these factors or fail to include them in ROI calculations. Failure to account for potential productivity dips during implementation can result in unrealistic ROI projections. It is essential to evaluate the impact of downtime and the time required for employees to become proficient in operating the new automated system. There are several losses associated with this the biggest one being the rework/waste that is generated due to automation. To give an example we will assume that due to automation line 70% efficiency for first month.

Overlooking maintenance and upkeep costs

End-of-line automation systems require regular maintenance and occasional upgrades to ensure optimal performance and longevity[5]. Neglecting to include these ongoing expenses in ROI calculations can lead to an inaccurate assessment of the true return on investment. Understanding the maintenance costs associated with the automated system and factoring them into the ROI analysis is crucial for making informed decisions. These three points are generally considered minor and neglected while calculating ROI, I will try to explain the impact of these in the below calculation.

The below calculations are for an end-of-line with two packing legs, each has 3 packers and then one carton filling labor at the end, so the target is 7 labor saving per shift, the cost of investment for this type of automation estimated is 750,000 USD, this is the average price for a mid-price range pick and place robotic solution.

In countries such as France, Germany, the UK, and Australia, the suitability of implementing a robotic solution becomes increasingly evident. A comprehensive analysis of the return on investment (ROI) reveals an estimated timeframe of just 1 year, based on initial calculations. This compelling ROI remains highly viable even when considering additional costs associated with the ramp-up phase, ongoing operations, and maintenance. The projected ROI timeframe slightly increases to 1.3 years, demonstrating a 30% difference. While the overall increase may not seem significant considering the initial 1-year ROI, delving into the details and factoring in the running costs of the robots unveils intriguing insights. These calculations present us with a compelling case that showcases the tremendous potential and financial benefits of embracing end-of-line automation in these countries.

In economies such as the USA, Japan, and Turkey, initial investment calculations may give the impression of reasonable viability. However, a closer examination reveals a precarious Return on Investment (ROI) standing at 2.9 years, teetering near the threshold. Misguided decisions or the introduction of additional complexities during robotics implementation can lead to escalated operational costs, potentially surpassing the 3-year ROI threshold. An intriguing observation is the impact of factors such as the cost of spares and electricity, which have the potential to push the ROI above the 3-year mark. Interestingly, when considering the cost of running the automation, the ROI time experiences a significant 55% increase, nearly double that of France's ROI calculations. Notably, the cost of electricity in the USA is considerably lower than in France, as the electricity cost is on the rise in the USA[1], further increases in electricity costs could push the ROI beyond the 3-year threshold, prompting investors to reconsider the quality of robots or think twice before proceeding.

In economies such as Saudi Arabia, Hong Kong, Estonia, and others, where minimum wages hover around $5, a preliminary analysis suggests that automation investments already approach a critical threshold. However, a more nuanced examination, accounting for commissioning, operational, and maintenance costs, reveals that the standard automation solutions surpass the 3-year return on investment (ROI) benchmark. Hence, it becomes crucial to exercise caution when selecting automation options. Certain high-speed production lines with minimal modifications emerge as viable investment prospects. This scenario can be categorized as an amber category, wherein automation holds potential in certain cases, but not universally, and standard solutions may prove impractical in many instances.

A recommended approach in countries like these would be to automate high-volume production lines that consistently operate at more than 90% capacity and involve well-established products with no frequent format changes. By focusing on such lines, efficiency is optimized, reducing downtime and breakdowns. These favorable conditions contribute to a decrease in ROI, making the automation investment even more advantageous. However normal lines with less than 80% Utilization and that involve format changes also will worsen the umbers beyond 4.4 years.

Table 1 ROI calculation for France

ROI calculation for France					
	Description	**Variable**	**Value**	**Formula**	**Units**
Project goals	Investment cost to replace 3 x 2 packers and 1 cartooning labor	A	**850,000**		USD
	Line crew before automation	B	16		Labor / Shift
	Line crew after automation	C	7		Labor / Shift
	Labor-saving	D	9	B-C	Labor / Shift
Anticipated ROI	Cost of labor per hour (as per minimum wages)[1]	E	12.6		USD / Hour
	Labor saved hours per day	F	216	Dx24	Hours / Day
	Saved cost of labor per year (80% utilization)	G	**783,821**	FxEx30x12x0.8	USD / Year
	ROI generally anticipated	H	**1.08**	A/G	Years
Real ROI considering cost of running and maintaining machinery — Cost of running	Running electrical load (average for this type of automation application)	I	50		KW
	Cost of electricity per KWH[2]	J	0.215		USD / KW
	Cost of electricity x (80% Utilization)	K	74,304	Ix24xJx30x12x0.8	USD / Year
	Cost of ramp-up time (Labor cost assuming 70% efficiency for first 30 days)	L	19,051	Cx24xEx30x0.3	USD
	Cost of ramp-up per year (Distributing total ramp-up cost to 5 years equally)	M	3,810	L/5	USD / Year
	Cost of breakdown (Labor cost for 1.5% downtime due to automation) x (80% utilization)	N	13,064	10x24x30x12xEx0.015x0.8	USD / Year
	Cost of rework (labor cost for 0.5% rework due to short stops of automation) x (80% utilization)	O	4,355	10x24x30x12xEx0.005x0.8	USD / Year
Cost of maintaining	Cost of spares per year for preventive and corrective maintenance (wear parts)	P	60,000		USD / Year
	Cost of overhauling spares (5 years maintenance)	Q	150,000		USD
	Cost of overhauling spares per year (Distributing overhauling spares cost to 5 years equally)	R	30,000	Q/5	USD / Year
	Cost of Preventive, corrective, and overhauling spares per year	S	90,000	P+R	USD / Year
	Technician cost per hour (2 x minimum wages)	T	25.2	Ex2	USD / Hour
	Maintenance labor hours per year for preventive and corrective maintenance	U	240		Hours
	Cost of maintenance labor per year for preventive and corrective maintenance	V	6,048	TxU	USD / Year
	Cost of maintenance labor for overhauling (5 years maintenance)	W	11,340	3x15x10xT	USD
	Cost of overhauling labor per year (Distributing overhauling labor to 5 years equally)	X	2,268	W/5	USD / Year
	Cost of preventive, corrective, and overhauling maintenance labor per year	Y	8,316	V+X	USD / Year
	Net annual saving	Z	**589,972**	G-K-M-N-O-S-Y	USD / Year
	ROI considering the running cost of the machine	Aa	**1.4**		Years

Table 2 ROI Calculations for the USA

ROI calculation for France

		Description	Variable	Value	Formula	Units
Project goals		Investment cost to replace 3 x 2 packers and 1 cartooning labor	A	**850,000**		USD
		Line crew before automation	B	16		Labor / Shift
		Line crew after automation	C	7		Labor / Shift
		Labor-saving	D	9	B-C	Labor / Shift
Anticipated ROI		Cost of labor per hour (as per minimum wages)[1]	E	7.3		USD / Hour
		Labor saved hours per day	F	216	Dx24	Hours / Day
		Saved cost of labor per year (80% utilization)	G	**454,118**	FxEx30x12x0.8	USD / Year
		ROI generally anticipated	H	**1.87**	A/G	Years
Real ROI considering cost of running and maintaining machinery	Cost of running	Running electrical load (average for this type of automation application)	I	50		KW
		Cost of electricity per KWH[2]	J	0.150		USD / KW
		Cost of electricity x (80% Utilization)	K	51,840	Ix24xJx30x12x0.8	USD / Year
		Cost of ramp-up time (Labor cost assuming 70% efficiency for first 30 days)	L	11,038	Cx24xEx30x0.3	USD
		Cost of ramp-up per year (Distributing total ramp-up cost to 5 years equally)	M	2,208	L/5	USD / Year
		Cost of breakdown (Labor cost for 1.5% downtime due to automation) x (80% utilization)	N	7,569	10x24x30x12xEx0.015x0.8	USD / Year
		Cost of rework (labor cost for 0.5% rework due to short stops of automation) x (80% utilization)	O	2,523	10x24x30x12xEx0.005x0.8	USD / Year
		Cost of spares per year for preventive and corrective maintenance (wear parts)	P	60,000		USD / Year
	Cost of maintaining	Cost of overhauling spares (5 years maintenance)	Q	150,000		USD
		Cost of overhauling spares per year (Distributing overhauling spares cost to 5 years equally)	R	30,000	Q/5	USD / Year
		Cost of Preventive, corrective, and overhauling spares per year	S	90,000	P+R	USD / Year
		Technician cost per hour (2 x minimum wages)	T	14.6	Ex2	USD / Hour
		Maintenance labor hours per year for preventive and corrective maintenance	U	240		Hours
		Cost of maintenance labor per year for preventive and corrective maintenance	V	3,504	TxU	USD / Year
		Cost of maintenance labor for overhauling (5 years maintenance)	W	6,570	3x15x10xT	USD
		Cost of overhauling labor per year (Distributing overhauling labor to 5 years equally)	X	1,314	W/5	USD / Year
		Cost of preventive, corrective, and overhauling maintenance labor per year	Y	4,818	V+X	USD / Year
		Net annual saving	Z	**295,161**	G-K-M-N-O-S-Y	USD / Year
		ROI considering the running cost of the machine	Aa	**2.9**		Years

Table 3 ROI calculation for Saudi Arabia

ROI calculation for France						
		Description	**Variable**	**Value**	**Formula**	**Units**
Project goals		Investment cost to replace 3 x 2 packers and 1 cartooning labor	A	**850,000**		USD
		Line crew before automation	B	16		Labor / Shift
		Line crew after automation	C	7		Labor / Shift
		Labor-saving	D	9	B-C	Labor / Shift
Anticipated ROI		Cost of labor per hour (as per minimum wages)[1]	E	5.13		USD / Hour
		Labor saved hours per day	F	216	Dx24	Hours / Day
		Saved cost of labor per year (80% utilization)	G	**319,127**	FxEx30x12x0.8	USD / Year
		ROI generally anticipated	H	**2.66**	A/G	Years
Real ROI considering cost of running and maintaining machinery	Cost of running	Running electrical load (average for this type of automation application)	I	50		KW
		Cost of electricity per KWH[2]	J	0.069		USD / KW
		Cost of electricity x (80% Utilization)	K	23,846	Ix24xJx30x12x0.8	USD / Year
		Cost of ramp-up time (Labor cost assuming 70% efficiency for first 30 days)	L	7,757	Cx24xEx30x0.3	USD
		Cost of ramp-up per year (Distributing total ramp-up cost to 5 years equally)	M	1,551	L/5	USD / Year
		Cost of breakdown (Labor cost for 1.5% downtime due to automation) x (80% utilization)	N	5,319	10x24x30x12xEx0.015x0.8	USD / Year
		Cost of rework (labor cost for 0.5% rework due to short stops of automation) x (80% utilization)	O	1,773	10x24x30x12xEx0.005x0.8	USD / Year
	Cost of maintaining	Cost of spares per year for preventive and corrective maintenance (wear parts)	P	60,000		USD / Year
		Cost of overhauling spares (5 years maintenance)	Q	150,000		USD
		Cost of overhauling spares per year (Distributing overhauling spares cost to 5 years equally)	R	30,000	Q/5	USD / Year
		Cost of Preventive, corrective, and overhauling spares per year	S	90,000	P+R	USD / Year
		Technician cost per hour (2 x minimum wages)	T	10.26	Ex2	USD / Hour
		Maintenance labor hours per year for preventive and corrective maintenance	U	240		Hours
		Cost of maintenance labor per year for preventive and corrective maintenance	V	2,462	TxU	USD / Year
		Cost of maintenance labor for overhauling (5 years maintenance)	W	4,617	3x15x10xT	USD
		Cost of overhauling labor per year (Distributing overhauling labor to 5 years equally)	X	923	W/5	USD / Year
		Cost of preventive, corrective, and overhauling maintenance labor per year	Y	3,386	V+X	USD / Year
		Net annual saving	Z	**195,025**	G-K-M-N-O-S-Y	USD / Year
		ROI considering the running cost of the machine	Aa	**4.4**		Years

Table 4 ROI calculation for India

ROI calculation for France

		Description	Variable	Value	Formula	Units
Project goals		Investment cost to replace 3 x 2 packers and 1 cartooning labor	A	850,000		USD
		Line crew before automation	B	16		Labor / Shift
		Line crew after automation	C	7		Labor / Shift
		Labor-saving	D	9	B-C	Labor / Shift
Anticipated ROI		Cost of labor per hour (as per minimum wages)[1]	E	0.547		USD / Hour
		Labor saved hours per day	F	216	Dx24	Hours / Day
		Saved cost of labor per year (80% utilization)	G	34,028	FxEx30x12x0.8	USD / Year
		ROI generally anticipated	H	24.98	A/G	Years
Real ROI considering cost of running and maintaining machinery	Cost of running	Running electrical load (average for this type of automation application)	I	50		KW
		Cost of electricity per KWH[2]	J	0.103		USD / KW
		Cost of electricity x (80% Utilization)	K	35,597	Ix24xJx30x12x0.8	USD / Year
		Cost of ramp-up time (Labor cost assuming 70% efficiency for first 30 days)	L	827	Cx24xEx30x0.3	USD
		Cost of ramp-up per year (Distributing total ramp-up cost to 5 years equally)	M	165	L/5	USD / Year
		Cost of breakdown (Labor cost for 1.5% downtime due to automation) x (80% utilization)	N	567	10x24x30x12xEx0.015x0.8	USD / Year
		Cost of rework (labor cost for 0.5% rework due to short stops of automation) x (80% utilization)	O	189	10x24x30x12xEx0.005x0.8	USD / Year
	Cost of maintaining	Cost of spares per year for preventive and corrective maintenance (wear parts)	P	60,000		USD / Year
		Cost of overhauling spares (5 years maintenance)	Q	150,000		USD
		Cost of overhauling spares per year (Distributing overhauling spares cost to 5 years equally	R	30,000	Q/5	USD / Year
		Cost of Preventive, corrective, and overhauling spares per year	S	90,000	P+R	USD / Year
		Technician cost per hour (2 x minimum wages)	T	1.094	Ex2	USD / Hour
		Maintenance labor hours per year for preventive and corrective maintenance	U	240		Hours
		Cost of maintenance labor per year for preventive and corrective maintenance	V	263	TxU	USD / Year
		Cost of maintenance labor for overhauling (5 years maintenance)	W	492	3x15x10xT	USD
		Cost of overhauling labor per year (Distributing overhauling labor to 5 years equally)	X	98	W/5	USD / Year
		Cost of preventive, corrective, and overhauling maintenance labor per year	Y	361	V+X	USD / Year
		Net annual saving	Z	(92,663)	G-K-M-N-O-S-Y	USD / Year
		ROI considering the running cost of the machine	Aa	∞		Years

In countries such as India, Pakistan, Bangladesh, Cuba, Nigeria, and other developing nations, the feasibility of implementing end-of-line automation becomes questionable, even when considering approximate calculations. The associated expenses related to setup, operation, and maintenance of automated systems outweigh the costs incurred when relying on manual labor for packaging tasks. Even in cases where fully utilized production lines with a single format are considered, the feasibility of achieving a favorable ROI remains challenging. In such scenarios, it is advisable to shift focus towards other improvement strategies, such as conducting time motion studies, optimizing job grouping through smart layout design, and implementing measures to enhance worker efficiency or improve working conditions. These types of changes have the potential to increase overall operational efficiency and may prove to be more beneficial compared to implementing robotics or automation solutions.

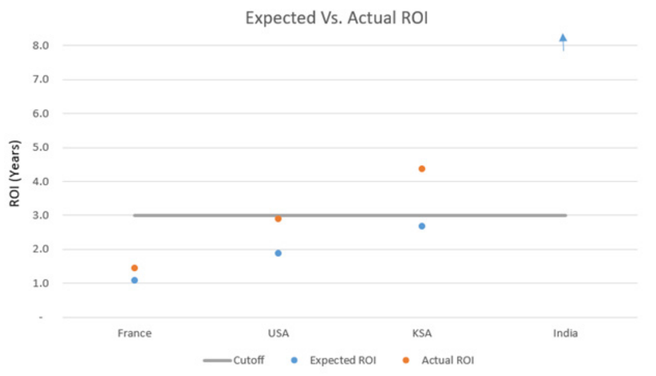

Figure 1 Expected Vs Actual ROI.

Conclusion

Based on the above calculations, we observe that the ROI time increases by 33%, 55%, and 65% in the economies of France, the USA, and Saudi Arabia, respectively, when considering the mentioned factors. Notably, in India, the cost of automated packing exceeds that of manual packing when all the mentioned factors are taken into account. This analysis highlights the misleading nature of anticipated ROI figures and underscores the need for careful consideration of all relevant factors and the cost of running automation systems. Additionally, it is important to factor in the quality of the robots themselves, as a low lifetime or poor energy efficiency can further exacerbate the increase in ROI beyond the figures mentioned earlier.

It is fair to say then that determining the return on investment (ROI) for end-of-line automation is a nuanced process that necessitates a comprehensive evaluation of various factors. Relying solely on labor-saving aspects while disregarding the intricacies and drawbacks of end-line automation can lead businesses to make inaccurate decisions that do not align with reality. By avoiding these common pitfalls and conducting meticulous calculations, a more accurate ROI assessment can be made, enabling better decision-making. Typically, businesses consider a three-year cutoff period for ROI when evaluating cost-saving investments. The chart below illustrates the anticipated versus actual ROI for end-line automation in the aforementioned countries, juxtaposed against the three-year cutoff line.

When analyzing the ROI of end-line automation across different countries, a clear pattern emerges wherein ROI increases from developed to developing economies. In developed economies where labor costs are considerably high and the expenses associated with operating and maintaining machinery are low, implementing end-line automation becomes a logical and advantageous choice that should be promptly adopted. ROI begins to rise when labor costs decrease and energy costs escalate. In these scenarios, making investment decisions regarding end-line automation becomes complex. Optimal levels of automation can still be feasible, but incorrect decisions or excessive automation beyond the optimal level can result in an ROI exceeding three years. In developed economies where manual labor remains more cost-effective than robotics, leveraging intelligent and application-specific tools, as well as poka yoke-type solutions, becomes more meaningful. This approach reduces labor requirements by simplifying and streamlining labor-intensive tasks.

Acknowledgments

None.

Conflicts of interest

The authors declares that there are no conflict of interests.

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