International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 14 Issue 7 July 2025 || PP 30-41

Standardization of the crossdocking merchandise classification process in Matec sorter

MBA.Ing.EverÁngelFuentesRojas[1], Javier Prada Amaya[2]
(1) (Industrial Engineering, Bogota DC/ Universidad Libre, Colombia)
(2) (Industrial Engineering, Bogota DC/ Universidad Libre, Colombia)

SUMMARY: *Merchandiseclassificationsystems are anessentialtool in companiesthatdistributelargevolumesofgoods, especially in sectorssuch as e-commerce, distribution, manufacturing, and retail. Global companieslike Amazon and Mercado Libre haveshownthattheimplementationofthesetechnologies can lead to precise and efficientmanagementthroughoutthesupplychain.Byimplementingadvancedclassificationtechnologies, companies can optimizetheiroperations, reduce costs, and improvecustomerexperience. Locally, wefindreferencecompaniessuch as Coordinadora Mercantil, Home Center, Prebel, amongothersthat are transformingtheiroperationswithautomation, reachinganunprecedentedlevelofefficiency, agility, and innovation. In theobjectofstudy, theresults are reflected in a coordinatedprocesswith a defined standard foreachoftheactivitiescarriedout in their respective stages. Throughthemeasurementofeachactivity, theexecution times and theallocationofthenecessaryresourceswereestablished. Allofthis, withthehelpofthetechnologyofthetool, allowedformeetingthecompany'srequirements. Forthisreason, thosecompaniesthatcorrectlyimplementthesetechnologies can significantlyimprovetheircompetitiveness and remainrelevant in currentmarket.However, itisimportanttoaddressthechallengesassociatedwithautomationsuch as changemanagement, training, compliancerisks, allofthis so thatthetransitionis as smooth as possible and thatalllong-termbenefits are realized.*

KEYWORDS – *System, Distribution, Innovation, Technology, Classification, Automation.*

Date of Submission: 11-07-2025 Date of Acceptance: 24-07-2025

I. INTRODUCTION

Automationbeginstotakeholdwhen machines starttobecomean indispensable tool in industries, facilitatingcertaintasks and jobsthatweredifficultforhumans; machines performedthesetasks more quickly and accurately. Accordingtoitsdefinition, automationistheabilityto use technologytoperformtaskswithminimal human effort. More specifically, automation describes thetools, techniques, and strategiesdesignedtominimizethe use of labor, which relieves employeesofworkload and allowsthemtofocusonotherresponsibilities[1].

Themainobjectiveofautomating a processistoimprovetheworkflow in thecompany, whichgoeshand in handwithcostreduction, increases in productivity, minimizationoferrors, and real-time control, byreplacing manual taskswith software thatsupportseachactivity, and thismust be perfectlyjustifiedwiththereturnontheinvestmentmade.
Withinthescopeofstudy, there are differentoperationalmodelsthatfittheneedsorcharacteristicsofeachcompany, frompharmaceuticalcompanies, textile industries, parcelservicestolargeconsumergoodsretailers, thesorterswhich in logistics are referredto as systemsforautomaticallysortingproducts and directingthemtopredeterminedconveyors, allofthisisbasedon prior programming and configuredtotheinternalhandlingcodes in eachcompany.

There are twoclassificationsystemsaccordingtotheircharacteristics, box classifiers and unitclassifiers, withthefollowingbeingthemostwell-known.

- Tray sorter. In thissystem, products are placed ontraysthatmovealong and whentheyreachtheirdestination, they tilt and are placed in thecorrespondingstation. Itsmain use isfordelicateorfragilegoods, as thetraysprovidestabilitytothe position oftheitem [2].

- Shoe sorter. In thissystem, productsmovealongthebelts, activating a systemofpushersthatlaunchtheproducttothepredeterminedexit, which can be another belt or a rampoutsidethe sorter[2].
- Vertical sorter. Thisis a space-savingsystem in whichproducts can be at differentlevelsorheights, allowingtheirsortingorfeedingto be done throughsynchronizedbelts [2].
- Cross-belt sorter. Itis a typeofcross-belt system, which has a veryhighsortingcapacity. It has theconvenienceofplacingitsconveyors in different positions fromwheretheproductisfed.Whentheproductreachesitsdestination, thecross-belt activates and allowsittomovetothecorresponding output[2].

In thisresearch, themainobjectiveisfocusedonthestandardizationoftheprocess, whichsuggestsadapting a standard foreachofthestepsbeingtakento complete thesupplytask, oralternatively, integratingtheactivitiesthatrequireautomationwiththosealreadyperformed, thusgeneratingthe new standard fortheoperation[3].

Standardizationwithinanoperation has objectivessuch as solvingproblems, improvingprocesses, generatinghigher performance, organizingactivities and context, improvingoutcomes, agility in decision-making, amongothers. Achieving a standard within a processbringsadvantages and benefitssuch as correctexecutionof work, reductionofcosts and time, improvement in servicequality, corporate culture, ease in managementbyleaders, allfocusedontheresultsofthecompany[3].

Standardizationwill be the guide that determines thepathtofollowthroughouttheprocess; forthis, itisimportanttoanswerquestionssuch as:

- Whatistheobjectiveoftheprocess?
- Wheredoestheprocessstart and end?
- Whichworkers are involved in eachexecutionstage?
- Isthere a previouslydefinedflowchart?
- What are theexecutionsequences?
- Whatresultsmust be delivered at theend?

Theestablished, measured, and correctlyexecuted step-by-step processwillallowtheteamtofocusontheprocess, identifyingimprovementopportunitieswhilehaving a 360° viewoftheoperation and aimingfortheresultsoftheproposedindicators.

II. METHODOLOGY

Themethodologyusedforthisprojectwill be a theoretical-practicalmethodof a descriptive nature. Thisstudywillbeginbycollectingalltheinformationthatmayinfluencetheclassificationprocess, fromthepreparationofgoodsbythe Pareto suppliers, schedulingappointments, deliveryofgoods, receiptofgoods, productconditioning, labeling and classification, in orderto describe eachoftheactivities and theirdeviations in thedifferentsamplesorauxiliariesthatperformtheactivities, aimingtogenerate a standard and productive process.

Thetypeofresearchforthisprojectis descriptive in naturewith a quantitativeapproach. Accordingto N. Nieto [4], theresearchaimsto describe and analyzethecharacteristicsorphenomenaof a specificcontextorpopulation. Fortheobjectunderstudy, a detailedanalysisoftheprocessesoperating in thedistribution center will be conducted in ordertoidentifyeachofthedeviationsthataffecttheoperationofthetool.

Thedistribution center managesprocessflowchartswithinitsoperationthatwill be analyzedforeachactivity and theadaptationofadditionalactivitiesthathavebeengeneratedbythecharacteristicsofthe matec Sorter, in ordertogeneratethe respective execution times thatwillallowtheestablishmentofthe standard forthe use ofthetool.

Withthequantitativeapproach, statisticaltoolswill be usedfortheanalysis and processingofthecollected data. Thiswillallowforobtaining precise resultsthatwillestablishthemeasurementindicatorsforthetool.

Theplansforthetool are sharedwiththeprimaryteamofthedistribution center, in orderto define thewarehousewheretheassemblywilltake place. Throughdesign software, differentlayoutsthat can be managed in theassignedwarehouse are simulated. Foreachoption, theteamsinvolved in theprocessesevaluatethe pros and consoftheassembliestheywouldcarryout, focusingontheoptimalflowofmerchandise transfer fortheoperation.

Whenhavingtoconnect a manual operationwithanautomatedprocess, itwasrelevanttocarryoutthedocumentmanagementofeachpart. Documentmanagementisknown as the set of rules appliedtomanagealltypesofdocumentsthat are created and received in anorganization, facilitatingtheirrecovery, allowingforinformationextraction, purgingthosethat are notnecessary, and preservingthosethat are importantfor as long as they are useful. Withthe diagnosis ofthecurrentprocessagainsttherequirementsofthe new tool, theobjectiveofthisreviewistoobtainthedetails and activitiesthatneedto be intervenedtoadapt and alignthetwoprocesses.

Basedontheinformationobtained in the diagnosis, weproceedtoestablishtheactivitiesthatshould be documentedorsupplemented in thecurrentones, in orderto define theresourcesthatwill be assigned in thedifferentphasesoftheprocess, seekingtohave a defined standard forthoseinvolved in thedevelopmentoftheoperation. Withthiscollectedinformation, a time study can be carriedoutbycomparingthecurrentsituationwiththe times ofthe new process.

Once the diagnosis ofthe use ofthe new tool has beenmade, theindicatorswithwhichtheefficiencyoftheprocesswill be measuredmust be established, evaluatingeachoftheaspectstoimprove and the new developmentsbeinggenerated in the machine. After reviewingeachofthestagesofimplementation, a final impactevaluationontheoperationiscarriedouttoprovidethefeasibilityoftheproposedchange.

III. DEVELOPMENT AND RESULTS

Prior totheentiredevelopmentofactivitiesfortheproject'sobjective, thescopeforinternal and externalmanagementofthestandardizationoftheprocesswasdefined. In this case, wedefinedinternalmanagement as alltheactivitiesthatmust be developed, modified, orimplementedfromthemomentthesupplierdeliverstheirproductstothedistribution center, and externalmanagementpertainstotheactivitiesthatsuppliers can carryoutfromtheoriginduringtheirpreparationprocesses.

Forthisscope, thedeliveryproviderswheresegmentedunderthepre-distributedflow, in whichtheloadingunits are alreadyprepared and organizedbytheprovidertakingintoaccount final demand, bothforfood and non-foodbusinessunits. Thisfirstsegmentcorrespondstowhat can be initiatedwithexternalmanagement, similarlywiththedeliveryprovidersunderconsolidatedflow, in whichthegoodsmust be handledtoadaptthemtotherequirementsofthe final customer.

Withthisresultidentified in thefollowing table, thedevelopmentofactivitiesisfocusedon a precise volumeofmerchandisemovement, whichrequiresgreaterinternalmanagementduringtheclassificationprocess (see table 1).

Table 1. Suppliersegmentation

DeliveryFlow	Food	Non-Food	Total, Flow
Consolidated	57	64	121
Predistributed	193	165	358
Total, Category	**250**	**229**	**479**

Source: Theauthor, 2025

Theobjectiveofthedocumentaryprocesswasfocusedondiagnosingthecurrentsituationoftheclassificationprocess in the Sorter Matec, conductingananalysisofeachdocument and adaptingittotheimplementationprocess, as well as constructingthe new toolsneededtocomplementtheoperation. Thefollowingitemsweretakenintoaccountforthisactivity:

- Sorter operation manual
- Sorter procedures
- Maintenance plan
- Similar logisticalsolutions
- Sorter operation software
- Software handlingrequirements
- Informationrecorded in the sorter software

- Processstatistics

In order, theoperation manual or as referredtobythemanufacturer, thetechnical data sheetofthe machine containsinformationthatfocusesontheoperationdirectlyforproductclassification. Basedonit, itisadaptedtothecharacteristicsoftheinternalcross-docking process.

Theadaptationtothecurrentoperationwascarriedoutwiththemeasurementofthetheoreticalstatisticsagainstthe actual processwiththepackagingconditionsused in Cross-docking. Accordingtotheinformation, the machine can process 5100 boxes per hour (see table 2).

Table 2. Feedingcapacities

DESCRIPTION	VALUE	UNITS
Feeding line 1 capacity	1.700	UPH
Feeding line2capacity	1.700	UPH
Feeding line3capacity	1.700	UPH
TOTAL SYSTEM CAPACITY	5.100	UPH
Recirculationline capacity	510	UPH
SORTER CAPACITY	5.610	UPH

Source: Sorter data sheet, 2024

Likeanyprocesspresentingdeviations, thecapacityoftherejection band is set at 2%, whichfor a processwiththevarietyofpackaging and theoriginoflabelssuitableforthe scanner isverylow. Measurementsweretakenbysupplier, packagingcharacteristics, and labeldevelopment, wherethe actual percentageoftheprocessisestablished (see table 3).

Table 3. Circulation and conformationcapacities

DESCRIPTION	VALUE	UNITS
Rejection output capacity (2%)	102	UPH
Storage outlet capacity (2%)	102	UPH
Palletizingcapacity	4.896	UPH
Number de outlets	10	Units
Palletizingcapacity / Output	489,6	UPH

Source: Sorter data sheet, 2024

Theinformationonthedimensionsthatthe machine acceptstoachieveitstheoreticalproductivity has a noticeabledeviationduetothevariety and characteristicsofsuppliersdeliveringgoodstothe CEDI. Itisnecessarytocarryout a study and identificationofthedifferenttypesofpackaging, assigning a valuethatgroupsthemwithin a similar range (see table 4).

Table 4. Informationsizing

PRODUCT DIMENSION	WEIGHT [kg]	LENGTH [cm]	WIDTH [cm]	HEIGHT [cm]
MAXIMUM	25	80	50	40
MINIMUM	2	15	10	20
AVERAGE	12	42	26,5	22

Source: Sorter data sheet, 2024

Theotherpoints in thetechnical data sheetemphasizehowtooperate and theprecautionswiththe machine, which are covered in the training fortheoperational staff.

Theinformationregardingdocumentsforthetoolislimited, whichiswhy a reviewoftheproceduresfortheentireoperationwasconductedtoadapttothe new processwiththe sorter, both in theactivitiesbefore and after the use ofthetool, basedontheprocesswherethe Sorter classificationsystemwasimplemented, and seeingalltheactivitiesinvolved, thefollowingprocedureswereadapted:

- Appointmentscheduling
- Receiptofmerchandise
- Picking ofmerchandise
- Merchandiseconditioning
- Merchandiseverification
- Dispatchofmerchandise

Theseproceduresthat are requiredto complete theoperationofthe sorter wereadded.

- Pre-distributedflowlabeling
- Automated picking consolidatedflow
- Consolidatedflowlabeling
- Productreclassification

Anotherimportantpoint relates tothe preventive maintenance plan, and thefrequencywithwhichitisbeingmanagedisquarterly. Duringthefirstyear, theresponsibilitylieswiththe machine seller, whomustnotonlycarryout preventive maintenancebutalsotrainthetechniciansofthepurchasingcompany. Fromthatyearonward, theresponsibilityfallsonthepurchaser.

A tour ofdifferentautomationsolutionsthathavebeenimplemented in varioussectorsofthemarketthatallowedfor a clearerpictureofthepathtofollowfortheobjective, frompackagingcompaniestomaterialscompanies, haveventuredintosortingtools, thefollowingcompanies can be recognized:

- SORTER COORDINADORA MERCANTIL

The sorter thatworks at Coordinadora isthemosttechnologicallyadvancedsortingtool in LatinAmerica; understandingthissortingprocesswillallowustoassimilatewhat can be achievedbyexploringthecapabilitiesofthetoolunderstudy [6].

- CROSS BELT SORTER – BLU LOGISTISC

Thetypeof sorter used in BLU LOGISTICS has thesamecharacteristics as the sorter understudy, whichallowsforidentifyingthedifficulties in itsimplementation and use. Theclassificationoftheproductshandledis similar tosomethat are alsohandled in the CEDI and are evendeliveredbythissamecompany, whichalsoenablescollaborative work [7].

- SORTER HOME CENTER

The HOME CENTER sortingtoolalsoinvolvesotheraspectsofrobotics and technology, whichis a plus in theentiresupplychainthat can be implemented in the future in thestudyoftheentire prior and subsequentprocessofsorting [8].

- NUTRESA

Nutresa's sorter allowsfortheclassificationoftheseorders, and withthesevolumes, it has beennecessarytostudywithindifferentareas, such as thehighlightedreviewwithinthehealth and safety managementsystem, focusingontheergonomicsoftheworkers in theprocess [9].

- AMAZON

Oneofthebottlenecksidentified in thesubjectofstudyisthemultipledestinationsinvolved; oneofAmazon'sstrengthsisthecodingforthedefineddeliveryareas, whichisanimportantpointfororganizingtheprocess in a more productive manner [10].

- MERCADO LIBRE MÉXICO

Oneofthecurrent premises in logisticsisfocusedondelivery times, which in Mercado Libre reach 16 citiesonthesameday, a challengethatmust be achieved in theprocessthatisbeingstudied [11].

- MATERIAUX - Automatedwarehouseforconsistent performance.

Theautomationimplemented in thiscompanyfromtwopointsofviewis comparable totheprocesscarriedout in theoperationunderstudy; theissueof pallet mobilizationboth at theentrance and the final assemblyisanopportunityforreview, and theergonomicaspectwhereitisevidentthatthemovementsto be performedwiththetool are repetitive, which can contributetothecurrentstudy [12].

Byinvestigatingthesolutionsimplementedacrossdifferentsectorsfromvariousfronts, itwasnecessarytoaddressthe control software ofthetooltoreviewitsscope and theinteractionforthepeopleinvolved in themanagement. In thisapproach, the SCADA systemisfound, whichisusedto monitor and control physicalprocessesinvolved in industry and large-scaleinfrastructureoverlongdistances, facilitating real-time feedbackwithfielddevices, generatingmobilizationinformationthatallowedforthestartofdefiningdifferentindicatorsfortheprocess and creatingflowdiagramsforthevariousactivitiesestablishedtoensuretheinductionrequirements in the sorter.

A flowchartis a diagramthat describes a process, system, orcomputeralgorithm. They are widelyused in numerousfieldstodocument, study, plan, improve, and communicateprocessesthat are oftencomplex in clear and easy-to-understanddiagrams [13], fortheobjectofstudythefollowingwerecarriedoutwhichallowedsegmentingtheactivitiestothenreachthe macro processofeachflow.

–Schedulingsuppliers
–Receiptofgodos
–Preparationof non-foodítems
–Preparationoffood
–Labelingofpre-distributedgodos
–Inductiontothe sorter
–Conformationbydestination
– Non-conformingproducto
–Additionstothecurrentprocess

Withthepreviousinformationabouttheprocessregardingdocumentation, reports, and flows, thenext step istounderstandwhattypeofmerchandisewould be handled in thetool. Forthe case oftheoperationofthecompanyunderstudy, itwasdividedintofivelargebusinesscategories: food, hygiene, liquor, home, and entertainment. Thestatisticsforhandlingthesecategories are calculatedfromtwofronts: thefirstwithdeliveredunits, whichmeasurestheproductivityoftheoperation, and thesecond, thevolumeofproductfortheformationof pallets and theloadingofvehicles (see tables 5 and 6).

Tabla 5. Participationunits

PARTICIPATION IN DELIVERED UNITS				
GC FOOD	GC CLEANING	LIQUORS	HOME	ENTERTAINMENT
49,1%	32,3%	4,5%	13,5%	0,5%

Source: Theauthor, 2025

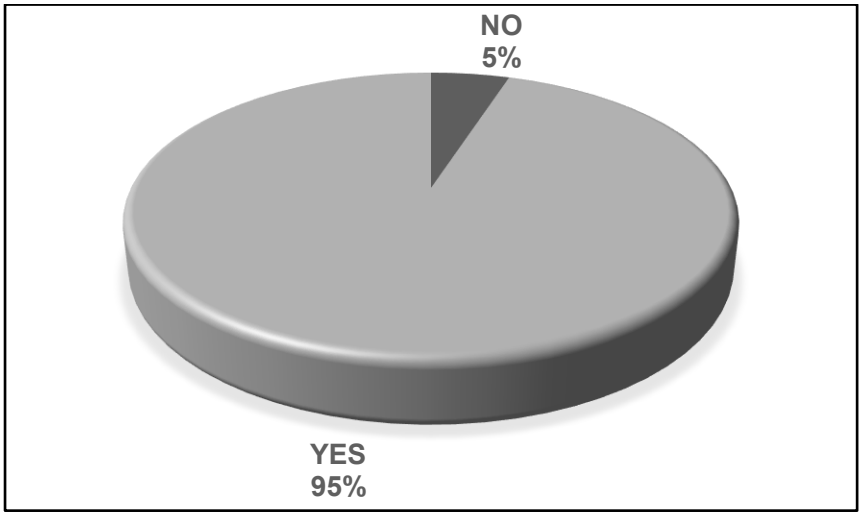
Tabla 6. Participación volumen

PARTICIPATION IN CARGO VOLUME				
GC FOOD	GC CLEANING	LIQUORS	HOME	ENTERTAINMENT
25,1%	27,3%	9,5%	22,5%	15,5%

Source: Theauthor, 2025

Duringthestudyoftheunits and volumesof cargo handledbythe crossdocking operation, thosereferencesthatmeettheminimum and maximumrequirementsthatthetool can process are identified, where 5% isdiscardedto be fedintothe sorter (see figure 1).

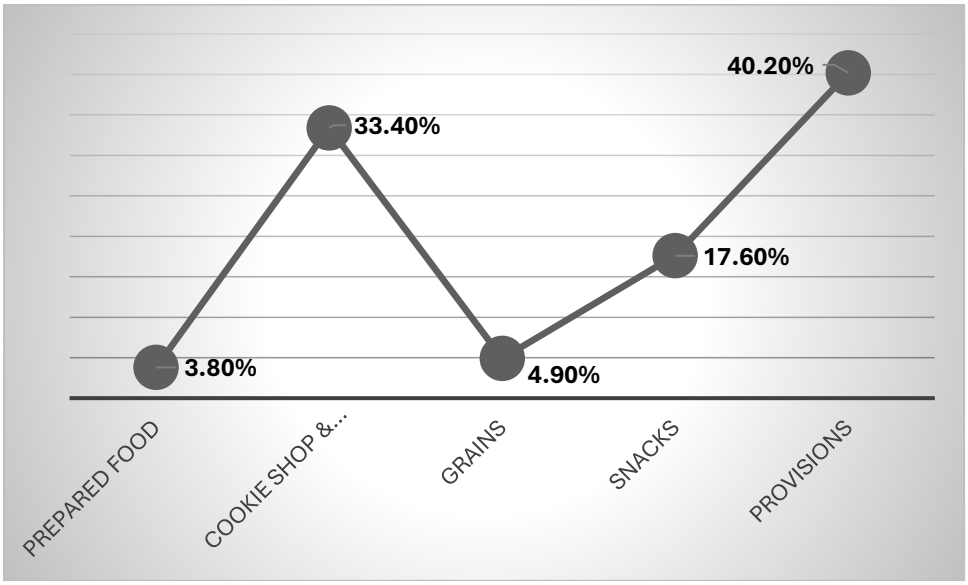
Figure 1. Percentageofproducttoprocess in the sorter



Source: Theauthor, 2025

Thesecategories are dividedintosubcategories, eachwithitscharacteristicsofhandling and participationwithintheoperation. Thisinformationis vital for work assignment in thetool, in whatordertheyshould be fedtoensurecorrectpalletizing, mitigatingbreakdowns in theprocess. Forexample, forthefoodcategory, thereisparticipationbysubcategory and itspriority in work assignment (see figure 2).

Figure 2. Foodcategoryparticipation



Source: Theauthor, 2025

In additiontothegroupingbycategories, theprocessmanages a flowofmerchandisedelivery, whichcorrespondstothecharacteristicsorconditionsunderwhichsuppliersmustdelivertheirproduct. Thiscondition has beenpreviouslynegotiatedbasedonthetypeofproduct and thesupplierdeliveringit; thisconditionisclassified and defined as follows:

- CERTIFIED PRE-DISTRIBUTED: Theproductarrives at the CEDI organizedby sales point, each sales pointislegalizedthroughan ASN that inputs the total amountofmerchandiserequestedbythewarehouseintothesystem.
- UNCERTIFIED PRE-DISTRIBUTED: Theproductarrives at the CEDI organizedby sales point, each sales pointislegalizedbyscanning box by box throughthe EAN 14 withrandominternalreview.

- CERTIFIED CONSOLIDATED: Theproductarrives at the CEDI organizedbyreference, the total deliveryislegalizedthroughan ASN generatedbythepurchaseorderthat inputs the total amountofmerchandiseintothesystem.
- UNCERTIFIED CONSOLIDATED: Theproductarrives at the CEDI organizedbyreference, itislegalizedbystackingeachreferencebyscanningthe EAN 14 withrandominternalreview and counting boxes per stack.

Thesuppliersforthedeliveryoftheirproductsmusttakeintoaccountallthephasesoftheprocessthatthecustomerrequires and theconditionsdemandedfromthepurchasetothereceiptoftheorder. This series of prior stages defines theoutcomeoftheexperience and a satisfactorydeliverybymeetingtheconditionsofthelogistics and distributionprocessoftheproduct.

It can be saidthat "Deliverylogisticsinvolvesalloperationsnecessarytoensurethattheproductreachesits final destination, meetingthedelivery time and in theconditionspromisedtothecustomer. Themainstagesoftheseoperations are: warehouseinventory, routeplanning, packaging and dispatchingofgoods, and transportation" [14].

Theprocessofplanningdeliveriesbysuppliers continues, establishingfrequencies, time slots, receivingcapacities, and assignedresourcesforthisattention. Allrelevant data forthisplanningissegmentedwithin a weekofoperation, wherethesupplycycleisfulfilled, ensuringthattheproductisavailable in each store. Thisplanningactivitymust be veryefficient and cost-effectivefromthesuppliers' perspective, especiallyduetothehightransportationcosts in the country, withthedistribution center providingexcellentservicetoeachsupplier.

In thedevelopmentoftheseactivities, itisimportanttokeep in mindsomeclarifications. The general measurementiscarriedoutthroughunitscorrespondingtotheenrollmentwithwhicheachproductisregistered in thesystemforlegalization. Theregistrationofmobilization in the sorter is done foreach box thatpassesthroughthesystem. Forexample, thecapacityfor NON-FOOD GEN and its respective deliveryflowistakenintoaccount, consideringpossibleseasonalvariations. Thiscapacitycorrespondstotheneedfordailyreceiptoperations and iscalculatedeachmonthbasedonthe sales projectionprovidedbythecommercialbusiness (see table 7).

Table 7. Non-FoodCapacities

NON-FOOD	FLOW	
	CONSOLIDATED	PREDISTRIBUTED
MAXIMUM CAPACITY	69.663	85.211
MINIMUM CAPACITY	95.944	9.056
AVERAGE CAPACITY	71.941	55.916

Source: Theauthor, 2025. Basedonthecompany'sdocumentation.

Toprovideexcellentservice, itisessentialtohavethenecessaryinfrastructure and human resourcesthatallowustorespond in a timelymannertoeachoperationordeliveryspecification. In thisassignment, the staff isdistributed as follows (see table 8).

Table 8. Personal Distribution

CROSSDOCKING OPERATING BASE		
TYPE	**PROCESS**	**PERSONAL**
UNITS ARE MOBILIZED	Receipt	24
	Conformation	18
	Evacuation	5
	Picking	42
	Induction	3
NO UNITS DEPLOYED	Leaders	3
	Pre-Invoice - Billing	9
	Godfather Plan	3
	DCILE - SupportGroup	3
	Tothe Administrative Staff	2
	Sorter Operator	1

	Cleaning at home	4
TOTAL, PERSONAL		117

Source: Theauthor, 2025. Basedonthecompany'sdocumentation.

In ordertooptimizethisresource, a time and motionstudywasconductedforeachactivity and movementrequiredwithinthedistribution center. Thefollowingpointswereidentifiedformeasurement:

- Receipt times byflow and characteristic
- Unitsreceived per time fraction
- Unloading times
- Travel times betweenzones
- Consolidatedflow picking time
- Pre-distributedflowlabeling time
- Pallet transfer times
- Circulation time in the sorter
- Pallet formation times
- Times forresolving non-conformingproducts

Whenperformingtheexerciseof times and movements, thepurposeistofindthebest and mostefficientmethodof work and STANDARDIZE it, thatistoestablish time standardsforeachactivity[15], in the time requiredto produce theproductor complete thetask in eachofthe work areasunder normal operatingconditions.

Validatedeachofthestagesfortheimplementation, a complete flowchartoftheprocesswascreated, startingwiththeconfirmationoftheappointmentmadebythesupplierforthedeliveryoftheirgoods, up tothedeliveryofthe pallet totransporttothewarehouse, eachoftheactivitiesthat are theresponsibilityofthe crossdocking team.

Theresultorprogressoftheimplementationshould be measuredbycomparingthemobilizationoftheunitsthatwerecarriedout in thepreviousprocesswiththeunitsthat are mobilizedusingtheclassificationtool. Undertheparameterofallocatingthesameresourceforbothprocesses, we can observe a comparative percentageofcomplianceagainstthe manual process, in itstwostages: thefirstwiththeprocessingof non-foodunits and thesecondwithfoodunits (see table 9).

Table 9. Mobilization per hour

STAGE	PROCESS	UNITS	% ADVANCE
	MANUAL	54.300	
1°	NO FOOD	30.000	55%
2°	FOOD	37.920	70%

Source: Theauthor, 2025. Basedonthecompany'sdocumentation.

Similarly, theprogressoftheimplementationwasevaluatedwiththecomplianceof OTIF for crossdocking flows, whereitwasevidentthatthegoals set bythecompanyforthisindicatorweremetduringtheimplementation. OTIF ismeasuredundertwoitems: thefirst, OT – ONTIME, correspondstoon-time arrival at thewarehousesundertheconditionspreviouslyestablishedforeachwarehousewith a servicepromise; thesecond, IF – INFULL, correspondstothe complete fulfillmentoftheunitsrequestedbyeachwarehouse.

Witheachoftheactivitiescarriedoutfortheimplementationoftheclassificationtool, alltheprocessesinvolved in thecorrectexecutionof crossdocking operationswereaddressed. Theissues in supplierdeliveries, errors in thelegalizationprocess, difficultieswiththeclassificationtool, and the manual tasksthatmust be performedtoensureproductavailabilityforthetoolwereidentified. Basedonwhatwasidentified at eachstage, conclusions and recommendationsforthecompanywereestablished.

IV. DISCUSSION

In thesameway as theimplementationisdetailed in thedocument, differentcompanies in the sector can be foundthathavedeveloped similar solutionsforexecutingtheiractivities, seekingto be more competitive in themarket and having control overinventorywithtoolsthatallowthemtomaintain total traceabilityoftheprocess and continuousimprovementassessment, as well as theevaluationof software usedforthe control and monitoringofoperations.

Thefirstreference, SUCCESS CASES, 'ShuttleWarehouseCollectorto Sorter' [16]. ThecompanySprinterisoneofthelargestchains in thesports sector, which has implementedtheShuttleto Sorter WarehouseCollectorprojectwithinitsoperation, executingit in a well-founded and innovative waytooptimize and automateitslogisticsprocesses. Throughtheintegrationofthe sorter, itsignificantlyincreaseditscapacitytohandle up to 3200 packages per hour, providing a directsolutiontothegrowingvolumeofSprinter's e-commerce.The use ofthisautomatedshuttle-typedrawersystemimprovesstorage and thusfacilitatesthedistributionofproductsacrossdifferentareas, optimizingoperations. Bymanagingqualitymonitoringstations, itsignificantlycontributestoreducingwaiting times and improvingresponsivenesstodemandpeaks, therebyhaving a dynamicvolumetricsystem.Thisprojectispresented as a clearexampleoftheimplementationofadvancedtechnologiesforautomation, optimization, quality control, and monitoringoflogisticsprocesses. Thisimplementationnotonlyimprovesproductivitybutalso positions thecompanySprinter as oneofthemost competitive in the e-commercemarket. Regardingtheobjectstudied, itiscloselyrelatedtotheproductivitythatshouldincreasethecrossprocess, but a significantdifferencefromthecurrent case istheproduct line, which has consequentlybeenoneofthemaindifficulties in theproject, as havingmultiplecharacteristics in itsproductsisnot comparable tocompaniesdedicatedto a singlebusinessunit.

Thesecondarticle, "Benefitsofimplementingautomation in processindustrialization" [17], emphasizesthemarketneedsregardingtheofferingofproducts and services. Forthisreason, thetransitiontoindustrializationinvolvesmakingdecisionsabouthow and wheretoinvest, thetechnologies, themachinery, and wheretostarttheimplementation, evaluatingtheadvantages in termsofefficiency, error reduction, savings in operatingcosts, future projection, and industrial safety. Comparedtotheimplementation done in thecrossoperation, thefocuswasonefficiency and savings, whichworked in itsinitialstagebutbecamestagnant in theprojectionthattheoperationshouldhaveto continue withautomation in 100% ofitsprocess.

Thethirdarticle, "Integrationofemergingtechnologies in industrial designfor more efficientmanagementoftransportation and logistics," focusesontheimplementationof new technologiestoimprovethe sector, includingthe Internet ofThings (IoT), artificial intelligence (AI), machine learning, augmentedreality (AR), robotics, and automationthat drive thistransformation. Fortheobjectofstudy, thelatterisperfect in itsanalysis, whereautomatedselection and packagingsystemssignificantly reduce processing times forgoods, improvingreliability in shipments. A fundamental premise in theobjectofstudyistheanalysisof times in ordertoprovideoptimalservicetocustomers, therebyoffering a greateropportunityfortheendcustomertofindeverythingtheyneedalwaysontheshelf.

The sorter classificationsystemprojectforthe crossdocking operationisanimportant step forthecompany, withautomationundoubtedlybeing a fundamental investmentthateverycompanyshouldevaluate. Whenanalyzingthemedium-termbenefits and results in theprocess, there are alwaysvery positive and relevantaspectsfound in thechangethatshould be projectedforthe future. Likewise, itisimportanttoconduct a prior studyofallthe variables thatmayaffectthedevelopmentoftheproject, from a simple flowofmerchandisemovementtotheselectionofthetechnologythatwill control thetool, as these can define theoutcomesoftheimplementation.

Undoubtedly, eachoftheanalyzedarticlespresentstheimportance and thewayforward forcompanieswithautomations; thedevelopmentof a projectofthisrelevancewillalwayshave positive aspects, and somethingveryimportantforthe future isthattheyallowforcontinuousimprovement and adaptationtothechangesthatneedto be appliedtotheprocess. Itisdefinitelyan alternative thatwillprovide a betterservice, which are objectivesalways set in organizations.

V. CONCLUSIONS

Thisstudyconcludedwith a comprehensive evaluationoftheentire crossdocking operation, uncoveringvariousopportunitiesforimprovement in theestablishedprocesses. Regardlessofthe use ofthesortingtool, standardization and improvementwereachievedtocontributetotheattainmentofthemetrics set bythecompany. Similarly, withtheimplementationofthetool, opportunitieswereidentified in handling and solvingissues. Foreachofthestages, thefollowing can be concluded:

Training and requirements in thedeliveriesofsuppliers, duetothenatureofthe crossdocking processforbothpre-distributed and consolidatedflowshavecertainconditionsregardingloading, labeling, monitoring, and documentation, whicheachsuppliermanagedaccordingtotheircapabilities. Theprojectallowedforengagementwitheachsupplier and formalizationofeachofthesconditions,

standardizingthisinitialstage and streamliningtheprocess in suppliermanagement.

Legalization and dispositionofproduct, duringtheunloadingprocess, the receivers are responsiblefordirectingthelocationofthemerchandise in thedifferentareasofthewarehouse. Prior totheimplementationofthe sorter, thelocationforlegalizingtheproductdidnothave a definedorder. Withtheproject, a plan wasestablishedtoorganizeeachproductbyitscharacteristics and opportunitytoenterthesortingtool, whichexpeditedthelegalization times and availabilityoftheproductforprocessing.

Picking and labeling; in the case of picking, itwas done withthehelpof radio frequency and onebyoneforeachorder. Withtheprojectlookingfor alternatives tostreamlinetheprocess, anautomaticprocedurewasestablishedfromtheinventorymanagerthatperformsthe picking and generatesthelabelsforenteringthe sorter. Thislabelingcorrespondstoanadditionalactivitytotheprocessthatinvolvedallocatingresourcesthathadnotbeeninitiallyplanned and didnotallowfor a returnoninvestmentfortheproject.

Features and sizing, thetechnicalsheetofthe sorter providessomespecificationstoachieveproductivity in the machine, thiscorrespondstotheappropriatemeasures so thatthespeedofthebands and thereliabilityofthe scanner performtheirtaskwell, thisisoneofthemaindifficultieswhenhaving a varietyofdimensions and characteristics in theoperation, beingoneofthemain variables toimprove.

Outgoingshipmentsformerchandiseconfiguration, the sorter in itsstructure has only 12 outputs which can be configuredaccordingtotheclassificationneeds, thedistribution center serves 267 warehouses, whichgeneratesdifficulty in themomentofconfiguringthatamountofwarehouseswith so few outputs, despitehavingthepossibilitytochangethestructure and expandthenumberof outputs, thespaces in thewarehouse and theinvestmentto be mademust be evaluatedverycarefully.

Manual and automatedprocesses, thescopeofautomationreached a midpoint in theoperation, whichmeansperformingthefirstpartmanually, theclassificationautomated, and thefinalizationagainmanually; thisdefinitelydidnothelptheproject'sobjectives and considerablyhinderedtheoperation.

VI. RECOMMENDATIONS

Takingintoaccounttheissuespresentedwiththe sorter classificationsystem, whichaffectsproductivity and generatesunforeseenreprocessing in operations, somerecommendations are establishedtoimprove machine efficiency.

Initially, the times forproductlegalization and disposal can be improved. This can be done byautomatingthelegalizationofcertifiedsuppliers, whichisfeasiblewithinformationsystemsthattransmitallinformationtothe CEDI inventorymanager as soon as thesupplierinvoices, allowingfor a simple clickto load allinventory.

Once thepreviouspointisimplemented, we can connectitwiththealreadyestablishedroboticstoprintlabels, thusadvancinganactivity and makingtheproductavailableforentryintotheclassificationsystemwell in advance.

Alongthesamelinesofadvancingwithautomationtopicsfortheshapingarea, massive data uploads can be implementedintothealreadyformed pallets, thisisfeasiblewitheverythingthat has alreadybeenprocessed and readbythe scanner. Additionally, thiswould free thehandsoftheoperatorssince radio frequencywouldnot be used at thisstageoftheprocess. To expedite theshaping, a lightingsystem can also be implementedto guide theassistanttowhereeach box arrivingontheconveyorgoes.

A structuralinterventionofthe machine isalsonecessary in ordertoimproveproductprocessing times. Thefirstrecommendationistoperform a diagnosticscantolookforwaystoenhancerecognition times. Secondly, theadaptationofthe 10 additional outputs that can be addedtothetoolisadvisable, allowingfor a betterdistributionofthewarehousesbeingserviced.

Itisalsopossibletostartevaluating in collaborationwiththesuppliersthepackagingunitsofsomeproductsthat, duetotheirdimensions, affectthetransportationontheentry and classificationbelts in ordertoimprovetheproductivityofthe machine.

Itisclearthattheserecommendationslargelyinvolve a financialstudy, butthey are providedtothecompanywiththeirargumentation so thatthey can be evaluatedwithinthedevelopmentoftheproject and theinitialobjective can be achieved, as well as thereturnoninvestmentbytheestablished dates.

REFERENCIAS

[1] Whatisautomation? (2022) https://www.servicenow.com/en/now-platform/what-is-automation.html
[2] Whatis a warehouse sorter orclassifier | SCM Logistics (scmlogistica.es). (January 24, 2023). www.scmlogistica.es/what-is-a-warehouse-sorter-or-classifier
[3] Standardization. (May 1, 2020). https://economipedia.com/definiciones/estandarizacion.html
[4]. N. Nieto. (2018). Typesofresearch. Santo Domingo Guzmán University, vol. 2, pp. 1-4.
[5]WhatisDocument Management? (June 21, 2024). https://start.docuware.com/en/blog/what-is-document-management
[6] A successstory: Themostmodern sorter in LatinAmerica. (April 25, 2021). http://mas.eafit.edu.co/academia/ciencias-aplicadas-ingenieria/un-caso-de-exito-el-sorter-mas-moderno-de-latinoamerica/
[7] BluLogistics, numberone in logisticssolutions. (2022). http://www.defencarga.org.co/contenido-sis/blu-logistics-number-one-in-logistics-solutions
[8]The Sodimac-Homecenter Distribution Center in Funza moves more than 7 million boxes a year. (April 2022). https://acis.org.co/portal/content/el-centro-de-distribución-de-sodimac-homecenter-en-funza-moviliza-al-año-más-de-7-millones
[9] Gloria Juliana Arias Paredes, Carlos Andrés Rueda Gaitán, Adriana del Pilar Diaz Manrique, Leonardo Augusto Quintana. Designofergonomicimprovements in the Picking Areaforthe CEDI of Comercial Nutresa in thecityof Bogotá [Degree Work]. Pontificia Universidad Javeriana. Javeriana InstitutionalRepository. (2019). https://repository.javeriana.edu.co/bitstream/handle/10554/44799/AriasParedesGloriaJuliana2019.pdf?sequence=1&isAllowed=y
[10] The Amazon sorting center equippedwithroboticsisnowfully open in theProLogis International Trade Park. (February 7, 2022). https://www-ttownmedia-com.translate.goog/tracy_press/robotics-equipped-amazon-sorting-center-now-fully-open-in-the-prologis-international-park-of-commerce/
[11] Mercado Libre automatesitsoperation in Tepotzotlán. (November 16, 2022). https://www.tyt.com.mx/nota/mercado-libre-automatiza-su-operacion-en-tepotzotlan.
[12]. Automaticwarehouseforconsistent performance. BestPractices Magazine. (27), 33-39. (2022). https://www.yumpu.com/es/document/read/67440927/revista-best-practices-n27-espanol
[13] Whatis a flowchart and howtocreateit? (February 17, 2025). Whatis a flowchart and howtocreateit? [2025] • Asana
[14] Everythingyouneedtoknowaboutdeliverylogistics and itsprocesses. (March 29, 2022). https://www.quadminds.com/blog/logistica-de-entregas/
[15] Time and MotionStudyWhatisit? Whatisitusedfor? Whatbenefitsdoesithave? (2018) https://ingeniia.com/newsletter-estudiodetiemposymovimientos/
[16] Success Cases, Shuttlestoragecollectorto sorter. (2018) https://lmgroup-es.com/colector-almacen-de-shuttle-a-sorter-sprinter/
[17] Moroni Vázquez Martínez, Alejandro Hernández Cadena, José Ángel Jesús Magaña, José Manuel Gómez Zea, José Ney Garrido Vázquez. Benefitsofimplementingautomation in processindustrialization. Innovation and technologicaldevelopment digital journa1. NationalTechnologyInstituteofMexico/TechnologicalInstituteof Villahermosa. (2023) 3_24_benefits-of-implementing-automation1.pdf
[18] Kelvin Eduardo Santos Pástor, Dayana Cristina Villarreal Meza, Edwin Aníbal Pilamunga Agualongo, Luis Antonio Ortiz. Integrationofemergingtechnologies in industrial designfor a more efficientmanagementoftransportation and logistics. KnowledgeHub. (2023). https://polodelconocimiento.com/ojs/index.php/es/article/view/6077/15331