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ARTIFICIAL INTELLIGENCE AND ROBOTICS IN LOGISTICS

Scenarios in the FMCG market

Introduction

In the '50s, the european distribution network of consumer goods was highly fragmented in millions of small shops.

In the '90s, with the advent of Big Retailers, small shops began to disappear and were replaced by supermarkets and superstores. This change resulted in a revolution of organizational and technological processes of logistics.

Today, the logistics of consumer goods is involved in a second revolution caused by Artificial Intelligence and Robotics applications.

Logistics is becoming increasingly essential to the consumer market accessibility, rendering irrelevant any distance. Maybe, very soon, we'll speak about of ISCM i.e. Intelligent Supply Chain Management based on Artificial Intelligence.

Why define logistics?

Up to a few years ago, logistics meant the sum of actions that permitted to "...bring the goods to the right place, the right way and in the right amount of time..." I don't agree with this definition mostly because one would need only a working brain to achieve that, so logistics has no place in this scenario. If, for example, a man purchases a flower bouquet for his wife, he doesn't need to be a logistics expert to choose the right street and the right time to get home, unless...he wants to sneak across town to drop off some of the flowers to a secret friend.

Later, the term Supply Chain Mangement was coined in order to modernize and adapt logistics terminology to the rapid increase of international trade, but in this case too we find the same activities, with different undertones, already inherent in the first attempts of defining logistics.

Often, the added value of any definition of logistics is almost zero and it is better to resist the urge to define logistics mainly because any definition implies barriers and restrictions in opposition to the logistics dynamism that, especially in the future time, will be very strong.

Logistics was born and evolved along with human intelligence.

In the early Palaeolithic Era- 2, 5 million years ago, - it constituted the key factor in human civilization and evolution.

The lithic technology used for obtaining food more easily, the conservation of foodstuffs derived mainly from captured wild animals and the migration from cold climates to warm climates carrying their rudimentary furnishings and food, prove that some of the basic principles of logistics like transport-management, stock-management, and the use of technology date back to more than 2 million years ago. Therefore, logistics can be considered a **primitive concept** (concept known for itself, and which should not be given any explicit explanation)

Some logistics flashbacks

Starting with Marco Polo and other pioneers of international trade, different countries began exchanging goods, technology and culture launching the process that, a few centuries later, was called globalization.

Adam Smith's insights gave way to mass production growth, most of which was transported in faraway markets thanks to a new means of transport - the trains, and to the railway infrastructure. It's easy to understand the strong connection between economic growth, transport and infrastructure.

In the 20th century, logistics was mainly seen as the management of transportation and distribution of goods to the shops and to clients. Later on, logistics extended its domain to the purchase of raw and semi processed materials, to production planning, warehouses management, distribution networks and customer care.

The development of the global economy, as a result of the migration of its center of gravity, has always depended on the swiftness of the decision-making process, on technology and the exchange of goods and information. But if the exchanges mean rapid transportation of goods, people and data, we have to acknowledge the fact that logistics will continue to be the guiding force of civilization.

THE VISION OF TOMORROW: TECHNOLOGY AND ARTIFICIAL INTELLIGENCE IN CONSUMER GOODS LOGISTICS

A premise

The following notes represented my personal vision regarding the near future of logistics, based also on the progress of artificial intelligence and robotics. In this new context, it would be arduous

to uphold the claim of a two-way link between logistics and primitive concept because of the impossibility to distinguish between the undisputable and the unpredictable.

The scenario

The term Artificial Intelligence (AI) was invented by John McCarthy in 1956. Since then, AI evolved and is now recognized as an independent branch.

Artificial Intelligence can be classified in two categories:

1. Narrow AI – for example the ability to solve CAPTCHA¹ or to make a search on Google
2. General AI that could replicate the majority of human abilities and presumably overcome them

The development of AI has brought concerns to a number of scientists and market operators. They fear that the AI systems won't do exactly what they are programmed to do, making mistakes that would have unpredictable consequences. In my opinion, the results of AI and Robotics development depend on the level of interaction between man and machine and on the ability of man to design accurate algorithms including all operational reality. For example, the transportation programs could be obtained by using AI applications, reducing or removing altogether the human involvement. The new plans of transportation executed by driverless trucks could be wrong only using a math model without all the variables that condition the success of the transport: predictable traffic, strikes, weather forecasts, and so on.

The good results attained from the studies and applications of AI encourage the biggest companies of technology like Google, Facebook, IBM, Microsoft, Apple, Amazon and others to invest enormously in the development of AI. The way of life and the habits of consumers are radically changing and, consequently, the supply chain management in market of FMCG will be involved from important technological and organizational innovations.

The simple tasks that are being performed by humans will gradually be performed by robots and, presumably, until 2020² intelligent machines will eliminate 7, 1 million jobs, creating only 2,1 million, for a deficit of around 5 million future unemployed.

Italy will not face the same fate in regards to the technological unemployment. One of World Economic Forum's report indicates that, from now until 2020, the fourth industrial revolution will eliminate 200 thousand jobs but it will create many others. In general, the increase in automation will create new job outlets: there will be a need for technicians capable of creating, activating, managing, programming and repairing the machines. Therefore, a mass professional

¹ CAPTCHA = Completely Automated Public Test to tell Computers and Human Apart

² An analysis presented at the World Economic Forum (Davos, Switzerland, January 20-23, 2016)

requalification will take place once more, as it happened after the last three industrial revolutions.

Softbot and Robot

Some scientists classify the machines that are the object of AI application in the following way:

1. Machines that think like humans. The objective is the replication of human thought
2. Machines that behave like humans. The objective is to create machines that would be physically identical to humans.
3. Machines that think rationally. The objective is to create machines able to make a rational reasoning.
4. Machines that act rationally. The main objective of this approach is creating a “new entity” (being) which could accomplish certain goals independently. The being would use rational thought to choose appropriate actions, but in certain situations it would have to react to environmental stimuli fast enough to override the choosing process. If one were to touch something very hot, the reaction is to retract the hand immediately, without using conscious thought; the being would have to be able to do the same thing, thus acting without thinking, what in humans is called ‘instinct’. These beings can be divided in two categories: the softbot – that consists of only software; the robot³ – that consists of both software and hardware.

Technological unemployment

1930, June. In Madrid, during the economic depression of that time, Mr J. M. Keynes stated that *“...What we suffer today is not the aches and pains of old age, but the aches of a progress made through swift changes, and the pains of readjustment from an economic time to another. The technical efficiency has intensified at a much more rapid pace than we were able to solve the labour incorporation problem”*.

Fortunately, in the FMCG Logistics sector, Keynes’ prediction did not come true, **but only until today!**

The displacement of productive activities in different countries all around the world continues to boost numerous logistics sectors like warehouses, transportation, distribution, information and data management. But until when will this progress spiral continue to feed itself? And more importantly, what are the challenges in technology and AI that we stand to face in the near future?

³ Source – Riguzzi Fabio, Terre di Confini Magazine

Artificial Intelligence: the use of robots in logistics

The Roland Berger Global Strategy Consulting has recently published a study dedicated to the use of robots in logistics, which came to the conclusion that a robot will come to cost half of the cost of a human worker, by 2020.

The change in the FMCG market is a continuous process, with no turning back, and the unstoppable development of the e-commerce will render the market attractive to new competitors, which, like Uber, will offer advantageous services to the final consumers with the help of Big Data, AI and technological innovations.

In the big Italian cities there are new competitors that are organizing their business according to the following model:

- a. the consumer chooses his favourite online store and picks the products he wants to purchase;
- b. a personal shopper chosen by the competitor makes the purchase;
- c. the consumer receives his shopping items at the place and time of his choosing.

Some new competitors are adopting losing business models just to assure themselves a position on the market for when the tide will turn. A phenomenon called “profit anticipation” by Kevin Kelly. Their initiatives are encouraged by the plunge of the three costs connected to:

1. Data processing. Processing costs are cut to half every two years on the same processing capacity (Moore’s law)
2. Broadband. Broadband costs drop 30% a year and its use rises by 60% a year, worldwide.
3. Data storage. In 1990 one Gigabyte cost about \$ 35.000, today it costs from 5 to 10 cents, which in statistical terms means a decrease of 50.000.000%.

The decrease in size is also going beyond the unimaginable limits. The smallest hard disk in the world is using atoms to store bytes with a density 500 times higher than the best devices on the market. It is as though one would store all the books ever written in a space no larger than a stamp⁴.

The New Transport Systems and Infrastructure

In the next few years, the organization and the systems of transport will experience important changes taking place in the FMCG market.

- The global transportation network will be more efficient with the help of the OBOR project, which was launched by the Chinese Government
- Air transport will increase, mainly within the FMCG market

⁴ Source-Kavli Institute of Nanoscience, University of Delphi

The OBOR project – One Belt One Road

China has launched, in the 13th five-year plan, a gigantic logistical plan (The New Silk Road), best known as One Belt One Road which will be developed over an area that represents:

- 55% of the world gross domestic product,
- 70% of the world population,
- 75% of the world energy reserves.

The project will be completed in the next 35 years. The investments will be supported by the AIIB Bank (Asian Infrastructure Investment Bank) which holds an initial capital of 100 billion dollars, of which China is the main shareholder with about 30 billion dollars.

63 nations have joined the project and Italy is participating with 2.5 billion dollars. OBOR will develop the land infrastructure – “the economic area of the silk road” and the water infrastructure- “the water silk road of the XXI century”. The FMCG logistics will play a key part in this project, where the presence of international competitors will stimulate new technology for managing enormous quantities of data, and new and faster product handling and transport systems.

The Italian Association, SCM-Academy, has started an international working group with the intention to propose the best suited infrastructure for the economy of each country. The current members of the Working Group are Economic Operators and Universities in Italy, China, Russia and Iran.

The new railway transportation

The Hyperloop transport system will revolutionize the railway transport system by connecting people and products at a greater speed than the airplane. Hyperloop Transport Technology plans to create railway connections using Maglev trains that travel at 1200 km/hour in vacuum-sealed tunnels. This would make it possible to go from Milan to Rome in less than 30 minutes. The Slovakian Government has signed a deal with Hyperloop Transportation Technologies to build the first European route for express transportation, and this is only the beginning of a new transportation logistics

The air transport

This transport system is currently used for transporting light and valuable goods (for ex. clothes, jewellery, etc.) and heavy and very valuable goods (for ex. a Ferrari car from Malpensa to China or other far-away countries) and is used very often. In the near future, is foreseeable that, with the lowering of costs, the FMCG sector will also be able to use air transport to deliver products

to and from different continents. It wouldn't be a surprise if certain e-commerce companies (for example, Chinese companies), which were using air transport, would intend to compete in the Italian market. The lowering of costs could be attained by using solar energy, as it was already done in the case of the Swiss airplane Solar Impulse, which, on the 26th of July has landed in Abu Dhabi after flying around the world. In this test phase, flying around the world took 16 months to perform, but this is only the beginning of future logistics.

City Logistics

The drone delivery systems and robots roaming on the streets will be a crucial part in solving the problems occurring in cargo and passenger transportation in urban areas. On a global level, more and more people prefer to live in urban rather than in rural areas. In 2014, the world population that resided in urban centres amounted to 54% of the total, and an UN study estimates that, up to 2050, approximately 70% of the world population will reside in urban centres. The phenomenon of population accumulation is taking place in Italy too. In fact, 60 million people live in 8000 urban centres, but the 10% of the population is amassed in only 4 cities (Rome, Milan, Naples and Turin).

The logistic changes of FMCG: The Italian scenario

In Italy (and in Europe) there is occurring another change in the market of FMCG, and consequently, in the logistics of the order-delivery process.

It is interesting to analyse the similarities between the changes that occurred in the '90s and those currently occurring.

- **In the '90s**, the Mass Market Retailers almost caused the extinction of small traditional businesses
- **Today**, the e-commerce represents a concrete threat to the development and survival of superstores, supermarkets and minimarkets. There are more and more families that choose not to wander around the store shelves but to purchase their goods directly from the "virtual stores". ESSELUNGA Company⁵ and other companies of modern trade are reorganizing the distribution logistic in order to meet the changing requirements of the FMCG market, which, in my opinion, is only a transitional phase towards the more evolved model that will be developed in the next few years.

Esselunga sends the home delivery one day after the order was made online and Amazon has announced that, initially only in Milan, it will deliver the merchandise to the client's residence in only one hour and a half after the order was made online.

⁵ ESSELUNGA is a leading Italian store chain in the supermarket industry

In Italy, there is one Amazon distribution centre of more than 70.000 m² in Castel San Giovanni, in the Piacenza province. In 2017 Amazon plans to open a new logistics hub of 60.000 m² in the Rome province, and an AI Research and Development centre near the city of Turin⁶.

Uber Eats, the food delivery system will be arriving in Italy in a short while⁷. After a trial period in Great Britain, Uber has decided to test the new service in another 10 EU countries, including Italy.

The consumers could in fact order their food from the restaurants and have it sent to their home or their workplace in a small amount of time. Only a few clicks on their smartphones away.

Fieldwork – the Lavazza case history

In the '50s, the Italian distribution network of FMCG was heavily fragmented and included about 500.000 (excluding peddlers) retail outlets: one small shop for every 100 citizens.

In the '90s, the big global companies of FMCG caused the drastic reduction of traditional shops by creating a new distribution network composed of hypermarket, supermarkets and minimarkets. The 25 Lavazza warehouses installed in strategic areas of Italian, lost their strategic value and became a considerable cost for the Company.

Lavazza was supplying about 70.000 retail stores and with less than 400 clients, covered 80% of sales.

As director of logistics, I reduced the number of warehouses from 25 to 2 units. I reached the efficient order-delivery process by building an automated warehouse near the factory. Using automated conveyors was possible to load trucks very quickly: 33 coffee pallets in 90 seconds. The first 400 clients were supplied directly from the automated warehouse and the small shops were supplied by 3PL operators. The production, logistics, administrative and commercial personnel was less than 1000 units.

Today, the Lavazza Company is one of the most important coffee production companies in the world. It is leader in the Italian retail market (44% market share) Lavazza Company sells its products in more than 90 countries: 20 billion cups of coffee per year⁸. More than 3.000 people work in Lavazza Company.

Keynes' prediction didn't include Lavazza and other companies like it which, by requalifying its personnel, have boosted sales and, consequently, the logistic and productive activities.

⁶ Source-Il Corriere della Sera, 22.07.2016

⁷ Source-Leonardo.it Hi-tech, 22.08.2016

⁸ 20 billion cups of coffee = about 120.000 tons of roasted coffee per year

	'90	Today	Δ %
Production of coffee cups	11 billion	20 billion	82 %
Order-Delivery Personnel	< 1.000	> 3.000	200 %

When I try to make a prediction regarding the future of logistics, other than analysing the studies of the best known representatives of the economic and logistic fields, I recall by own mistakes as a logistics manager. One of those concerns the design of the automated warehouse at Lavazza, built with self-supporting shelves, two pallets deep, and provided with four automated stacker cranes that store and retrieve coffee pallets in and out of the 11.000 possible locations. During the building of the warehouse, the focus of the ABC on only 15 articles out of 100 products helped with the two pallet deep shelves.

Today, the company sells about 1000 different articles and the warehouse is used as a temporary stocking space. Presumably, if we were to have had available the Big Data on consumer habits and the help of AI, me and my collaborators would have made different decisions.

The business planning and sales predictions that were being realized with the help of Box-Jenkins and Lewandowski models, would have been more reliable with the use of the myriad of data regarding consumer habits in countries all over the world. The automated vertical warehouse, which was built this way to fit the area restrictions near the production building, could have been designed to have grid shelving with the use of robotics and AI, and also to use all the available space around the production building in a "U" shape, so that the possibility of utilizing intelligent shuttles to carry out the input/output operations according to the consumer purchases, could become a reality. Today, the picking operations that are limited to deliveries of class "C" articles are being done by warehouse workers, but it's predictable that in a short while this job will be entrusted to intelligent robots with a perceivable lowering of logistic costs.

Conclusion: logistics in the near future

In the near future, a percentage of the deliveries carried out by express couriers will be performed by drones and robot mail carriers (6 wheel-robots that home deliver mail). Amazon was authorized to perform tests in rural areas of Great Britain, using drones capable of transporting packages up to 2, 3 kg. The Starship Technologies company has already engaged in a number of trials around the world, the latest of which is with Swiss Post, the national postal service in Switzerland.

These innovative home delivery methods that seem unreal today, tomorrow could become a logistic routine equal to other ambitious plans that nowadays are a part of our daily lives, like supplying space stations.

For example, on July 18th the mission CRS-9 was launched. The second generation Falcon 9 has taken into the orbit for the second time this year a Dragon ship full of provisions and tests for the Expedition 48 crew. The Dragon CRS-9 cargo module has concluded its restocking mission to the International Space Station on August 26th, when it returned by diving into the Pacific Ocean, South-East of Baja California, carrying precious cargo which consisted in NASA technologic experiments and information. Is this “logistic delivery” to space more complex than drone deliveries? Is depositing a pallet on a shelf more complex than the coupling of a space module to a space station which is executed by “simply” using a robotic arm

The impact of AI on logistics is unimaginable for us. Unfortunately, in Italy there are some very dire predictions for some Cooperatives and Service Companies, which, lacking in technical skills, have become Logistics Operators. In a short while, these third party companies will disappear because they will not be able to compete with AI applications and robotics. The robots will be able to execute different logistic functions at lower costs than what human operators are being paid today. In parallel to this depressing scenario, on a more optimistic note, Universities are training excellent logistic specialists able to manage the future Supply Chain. The unemployment of basic labourers will, therefore, be balanced by an increase in specialized workforce which will probably be the protagonist of the **fifth industrial revolution**.