AUTONOMOUS STORES

FINAL REPORT | 2025

© Ana Viseu

- Ana Viseu
- João Pedro Pereira
- Ana Delicado
- Paulo Nuno Vicente
- Hande Ayanoglu
- Pedro Lucas

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The project

'AutonomouStores: Sociotechnical Infrastructures, Imaginaries and Data Governance' is a research project funded by Fundação para a Ciência e a Tecnologia (2022.02730.PTDC). The project ran for two years (between March 2023-2025) and comprised a multidisciplinary team led by Prof. Ana Viseu (PI). The project was hosted at ICNOVA, the Communications Institute and Research Center of Faculdade de Ciências Socias e Humanas, Universidade Nova de Lisboa.

'Autonomous stores' are often characterized in the media as the future of shopping: intelligent spaces without cashiers or employees and filled with tech that can identify consumers and their actions, saving time and increasing convenience. References to autonomy and automation invoke a set of imaginaries related to ideas of technological innovation and progress. Despite the name 'autonomous', these spaces rely on vast infrastructures that involve people, knowledges, and numerous technologies (such as, Internet of Things, AI, sensors, algorithms, computer vision, machine learning).

The main goal of this project was to examine the imaginaries and practices behind the emergence of so-called 'autonomous stores' to understand the worlds they are creating. To do so, we developed activities across two main axes:

1. An examination of the imaginaries of 'autonomous stores' as they are portrayed and created in the national and international media. We conducted a thorough review of Portuguese media (generalist and specialized) while also focusing on renowned venues with global readership.
2. Case study and interviews with main actors in the autonomous stores landscape. Focusing primarily on the Portuguese landscape we performed 17 interviews with representatives from corporations, R&D funding and oversight agencies and data protection officers.

For the past 2 years we participated in several events, gave multiple talks at conferences, engaged in science communication and outreach, and contributed to scientific knowledge with book chapters and articles. All our activities are detailed in the project's website.

www.autonomoustores.net

Team

Ana Viseu (PI), Paulo Nuno Vicente (Co-PI), Ana Delicado (Senior Researcher at ICS, Univ. de Lisboa), Hande Ayanoglu (Assistant Prof. at IADE, Univ. Europeia), João Pedro Pereira (Research Assistant), Pedro Lucas (PhD student, NOVA FCSH)

Methodology

The project encompassed five principal tasks:

1. Mapping the network of actors involved in autonomous stores;
2. Examining the sociotechnical imaginaries of autonomous stores;
3. Two case studies;
4. Final project workshop;
5. Communication and dissemination

To conduct these five tasks we relied on several social sciences methodologies, namely:

- **Documental analysis**: We conducted a literature review that included scientific articles as well as reports, national and international legislation, websites, et cetera. There isn't much published on autonomous stores so we tried to cover as much ground as possible.
- **Media analysis**: We conducted qualitative analysis of articles published in national and international media venues between 2016 and 2023. Our final sample was constituted by 137 articles. The articles were analysed using MaxQDA following a thematic analysis1 (Braun & Clarke 2004)
- **Case studies**: While initially we had planned to conduct an ethnography focused on one store, we ran into problems and had to re-adjust our research design. We ended up conducting complementary case studies of two large Portuguese corporations: GALP and SONAE MC (Continente).
- **Semi-structured interviews**: We conducted 17 interviews with several key stakeholders including representatives of the companies listed above but also representatives of R&D funding agencies and data oversight commission. The interviews were analysed using MaxQDA following a thematic analysis approach (Braun & Clarke 2004)
- **Fieldwork**: We conducted fieldwork in several shops (large and small). Where we experimented with the 'intelligent' payment systems and partook in customer experience.
- **Final workshop**: The final project workshop was conducted in Jan. 2025 and involved members of the public, project participants, project consultants and artists.

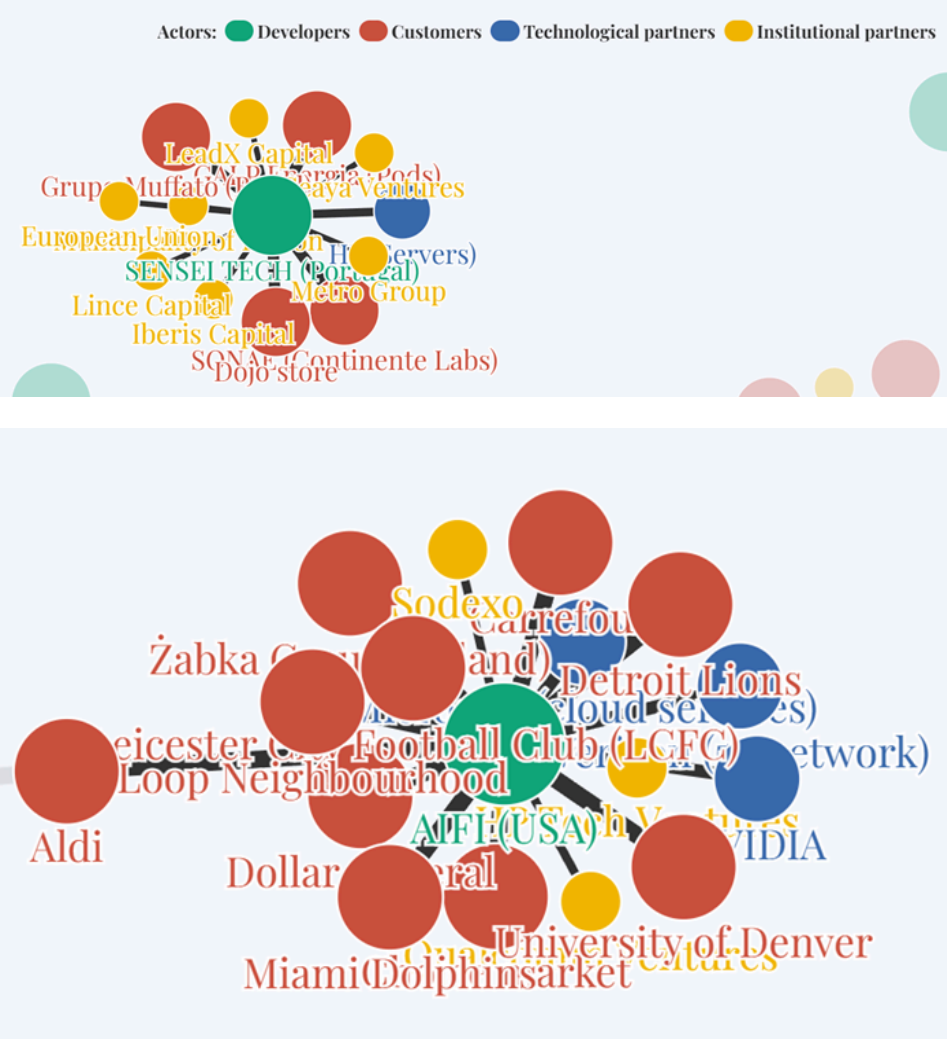
Mapping the actors

Who is involved in the development of autonomous stores?

Our first task consisted of mapping the field of autonomous stores to better understand the actors involved in their creation - both nationally and internationally.

These maps, while necessarily incomplete and partial (and while also ever changing), gave us a good idea of the broad scope of actors with stakes in this emergent field. These maps also show us the main areas of application of autonomous stores. We distinguish between:

- Developers (companies specializing in the development of AS technology)
- Customers (retailers and others)
- Technological partners (companies that develop technology that is being adapted to AS)
- Institutional partners (partners that are sponsoring and investing in AS)



Partial views of the actor map, focusing on the main national (Portuguese) actors. Extracted from: https://autonomoustores.fcsh.unl.pt/?page_id=228 (December 1, 2024)

We can draw some conclusions from these maps:

1. **AS are a (potential) big market**: Autonomous stores involve several key technological partners (like Microsoft and NVIDIA). It is therefore a big business.
2. **AS has several main application areas**: Food retail (supermarkets and convenience) are key amongt them, but also places of passage where people tend to be in a hurry (like stadiums, airports, and gas stations), and finally places where there are many young people/consumers (like universities).
3. **AS has only a few main dedicated tech developers:** When it comes to the development of AS infrastructures there aren't that many players. Among them Amazon rules. In the Portuguese landscape, Sensei Tech is the main actor.

Media Analysis

Sociotechnical Imaginaries

How do the media portray and create autonomous stores?

While there is no widely accepted definition of 'autonomous stores' (AS), they are typically described as AI-powered physical spaces that monitor customer interactions, automatically bill for items, and allow customers to simply pick up goods and leave without the traditional checkout (Phillips, Russell-Bennett & Kowalkiewicz, 2022). Media often describes autonomous stores as the “store of the future” (NYT, 2018, news article) and the “future of shopping” (The Guardian, 2016, news article), demonstrating how technology can enhance everyday life (PT specialized media 2023, news article). These stores are expected to disrupt retail and consumption, conflating imaginaries of technological progress in the service of consumer convenience and automation.

We set out to examine the “sociotechnical imaginaries” (Jasanoff & Kim, 2009; Jasanoff, 2015) of autonomous stores that circulate in news media. Defined by Jasanoff (2015: 4) as “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology”, sociotechnical imaginaries highlight the performative role of discourse and imagination in bringing entities and worlds into existence.

Our analysis was driven by two research questions: **What visions, fantasies, problems, and fears about AS circulate in the national and international media? And, What discursive strategies are used to drive, justify, and normalize the materialization of these imaginaries?**

As detailed in the methodology, our sample was composed of a total of 137 articles:

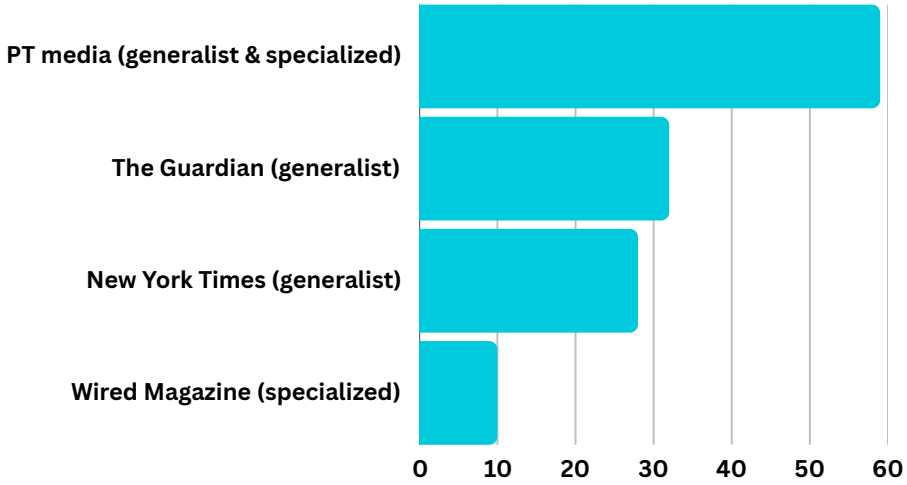


Figure: Our sample of media articles published between 2016 and 2023

"[Sensei's] mission is to create smart stores that intuitively understand customers' needs and help retailers provide them with a more convenient, frictionless and personalized experience and service than has been possible to date"
(PT specialized media, 2018, news article, our underline)

The quote above because it gives a good sense of how AS are portrayed in the media. They are seen as equivalent to 'smart' / 'intelligent' entities who "intuitively" (that is, almost humanly) understand the "needs" of customers - those needs being personalized and frictionless service - while simultaneously (and apparently in parallel) helping retailers by providing them with the data that can afford such experiences. That these shops are still experimental and unstable goes unmentioned in media imaginaries. That data is extracted through surveillance is also not largely unsaid. That the needs of customers and retailers may not be the same is further not discussed. Finally, that these needs are being imagined through the lens of companies with vested interests in their development is unchecked.

Highlights

Our findings underscore several important aspects pertaining to the development of autonomous stores.

1. The media make extensive use of interviews with industry representatives. Their views - often the public relations discourse of the companies they represent - are cited not necessarily as opinions but rather as facts. Like Mager and Katzenbach (2021) before us, we found that tech companies are key drivers of the futures being created in the media.
2. Although the 'autonomous store' is still a novel and unstable entity - both in terms of its definition, its implementation and its viability - the media treat these entities as if they real and inevitable.
3. Autonomous stores are depicted as part of futuristic narratives that connect them to imaginaries of innovation and progress.
4. The media tend to confuse who the users of autonomous stores are, oscillating between consumers and retailers, and imagining their needs and goals as one and the same.
5. Examination of the implications of autonomous stores are sparse and simplistic, often following a binary logic offering utopian/dystopian visions of increased unemployment and hyper-surveillance or the humanizing power of technology and hyper-convenience. Largely absent are critical analyses of the racialized and gendered histories of automation as well as discussions of what happens to the data that is being collected from autonomous stores.

Utopian	*Dystopian*
"The accounting is easier. More data can be gathered to track sales, understand buying habits and potentially market to costumers." *(The Guardian, 2018, news article)*	*"Going to the supermarket is one of the most mundane, everyday things we do. The fact that surveillance and data gathering in such a space is being normalised is deeply troubling"* *(The Guardian, 2022, news article)*
"Robots will take on the more repetitive tasks, freeing up staff to offer more expert and personalised advice" *(The Guardian, 2017, analysis piece)*	*"And really, it is just the next logical development from the automated checkouts already in use in most supermarkets [...]. So by any measure, it's hard to see how an operation like Amazon Go doesn't ultimately mean fewer jobs"* *(The Guardian, 2016, news article)*

For more on our media analysis see: Viseu, A., Pereira, J. P. & Delicado, A. (*in press*). Smartness as a new paradigm for retail? Sociotechnical imaginaries of autonomous stores in the media. In Orrù, P. & Lupano, E. (Eds), *Artificial intelligence and human perception: Media discourse and public opinion*, FrancoAngeli.

Case Studies

Implementation of Autonomous Stores

What and who is driving the development of autonomous stores? What worlds are they creating? What are their implications?

As stated before, Portugal is home to Sensei Tech (hereafter Sensei), one of the “key” autonomous stores’ tech developers. We place the term key in quotations because this statement was contested by the rep for the international company we interviewed. However, if there may be some dispute as to their status in the international scene, there is none as to their status in the national landscape.

Sensei has been hailed as one of Portugal’s innovation success stories, and in 2021 it was widely reported in the media that it was collaborating with SONAE MC (who owns and operates the Continente supermarket chain store) to open the ‘Continente Labs’ store. As stated before our initial intention was to conduct an ethnography of this store. However, by the time we were in the field, it became clear that (a) we did not have sufficient access, for instance, the data and algorithmic infrastructures were completely off the table, and (b) Sensei was also working with another large corporation, GALP (PT’s oil and energy corporation) to experiment with autonomous stores. We switched gears and decided to conduct two complementary case studies focused on SENSEI’s entanglements with these two companies, as well the funding, innovation and monitoring entities that sustain their activities.

These case studies were open-ended and exploratory. The main research question driving them was, **What are the worlding practices of autonomous stores? Who is driving them and why? What transformations derive from their existence and use?**

We conducted a total of 18 interviews involving 19 participants. The table below provides a record of this - with several strategies deployed to protect the identity of those who worked with us.

Pseudonym	Title	Organization	Actor Type
Participant 1 (2 interviews)	Senior manager	SENSEI	Tech developer
Participant 2	Funding manager	SENSEI	Tech developer
Participant 3	Innovation manager	GALP	Retailer
Participant 4	Commercial manager	GALP	Retailer
Participant 5	Store project manager	GALP	Retailer
Participant 6	Digital & Mobility manager	GALP	Retailer
Participant 7	Digital & Innovation manager	SONAE	Retailer
Participant 8	Project manager	SONAE	Retailer
Participant 9	E-commerce manager	SONAE	Retailer
Participant 10	R&D manager	SONAE	Retailer
Participant 11	Senior member	AiFi	Tech developer
Participant 12	Senior member	CNPD	Data regulator
Participant 13 (2 part interview)	Senior member - Agenda setting	Unicorn Factory	Business incubator
Participant 14	Senior member - Entrepreneurship & Innovation	IAPMEI	Supervisor - Funded projects
Participant 15	Senior member - Corporate Capacity Building	IAPMEI	Supervisor - Funded projects
Participant 16 (various persons)	Digital transition	Recuperar Portugal	Agenda setting - Funded projects

Table: Description of case study participants

Highlights

What is an autonomous store?

We were surprised to learn that our participants have very different views of what an autonomous store is. Sensei, as depicted on its website, says it has 3 products: autonomous stores, pods (convenience stores containers), and cabinets. These definitions are largely shared with Continente. However, GALP sees pods as its autonomous stores (called 'smart stores') and defines autonomous stores as 'hybrid stores'. Their hybridity comes from having staff rather than being totally unmanned. This in many ways reflects the still unstable identity and existence of AS.

3 different categories of beneficiaries identified

One of the things we learned is that those involved in the business identify three beneficiaries of AS (introducing a third actor not mentioned in the media). Participants we spoke to understand that the gains for each of these actors is different.

Clients (in the store)	*"The big advantage, compared to a regular self-checkout, it's really how faster it is. There is no need to scan the products, the basket appears in the moment and it's just a matter of validating"* (Participant 10, SONAE)
Retailers	*"There is clear an operational advantage in terms of the data gathered to support re-stocking, for availability in store and even that type of data that I was talking about that could be sold to the brands" (Participant 1, SENSEI)*
Brands	*"Given the fact we know where the clients are most of the time, where the clients touch, which products the clients grab and then return (to the shelves), this type of data we can (...) sell it to the brands because these are highly valuable data and brands nowadays do - they create labs to try to figure out how the client behaves - and we are able to have a lab (...) in a real store" (Participant 1, SENSEI)*

Importance of data in the business model and privacy questions

Participants acknowledge that the extraction of data from the store - a hypervigilant space - is one of the big gains of AS. However, all are quick to point out that as it stands this data is not (yet) being used and that it poses new challenges when it comes to meeting the legal

requirements. Furthermore, the regulator sees it as a potential problem not only for customers but also for employees.

- *“Because, in essence, with this type of technology, we can see which areas of the store have the most traffic, the least traffic, the most interactions, the interactions that result in purchases, the people who pick up the product but only to look at it and put it down and end up not buying it. And then we can cross-reference this with other, other parts of the company itself to help with our decisions, even if it's in terms of communication, price and the like. Because we can identify this type of customer behavior that needs some revision of the decisions we're making regarding that product, regarding the location of the product.”* (Participant 7, SONAE)

- “*There is still much opacity about what is on the other side (...) just looking (I) might not be aware of all the risks because i don´t have a complete understanding of the technology*” (Participant 12, CNPD - National Data Protection Commission)

Transformations in the labor market for the retail sector

One of the contested things about autonomous stores is what ‘autonomy’ might mean. Participants alternate between insisting that autonomous stores will not lead to automatization and the layoff of staff - at least not at the companies they represent - and the recognition that the business model behind AS is one where they are unmanned. This question is an important one also for the regulators, since national funds are being invested in an endeavor that may well lead to unemployment.

- *“I would define a[n autonomous] store [as one] in which the customer is able to enter and leave without having to have any kind of contact or support with employees to make this entry and exit process.”* *(Participant 7, SONAE)*

- *“Then, as I was saying, it will have an advantage in terms of reduction, an advantage for the company, in terms of reducing the number of people. So I'll need fewer people. And here, mind you, as I've already explained, not necessarily in the GALP context, not necessarily in convenience stores. But when it comes to retail, it's inevitable. Therefore, the stations, as is happening with the self-checkout, this is another enabler, it's to be reduced.”* (Participant 4, GALP)

- *“The return is always for the expenditure we don't have... So it's always twofold: it's the expense we don't have with people on the checkout line.”* (Participant 9, SONAE)

What is the “reality” of autonomous stores? It is both uncertain and a ‘sure thing’

Although SENSEI presents AS as the present and future, its promoters are still uncertain about the business models that underlie them. Many discuss these partnerships as fruitful collaborations and learning experiences, explaining how this is what drives their efforts. Another important drive - acknowledged by retailers and used as a sales pitch by the tech developers - is the difficulty in hiring cashier staff. However, all acknowledge roadblocks such as costs (technology, maintenance, electricity, for instance), legal (compliance with GDPR, for example), or the lack of a working business model. We found no evidence that autonomous stores - as currently implemented by SENSEI - will stabilize.

- *“Yes, the first motivation was never the question of return [on investment]. The first motivation was to test and pioneer this technology. It was to understand how far this could take us. What could we do? And what could we learn? And that's what we've been learning, from the first iteration to this second, third iteration that we're on, we're on a path of learning what customers want, what the technology can offer and what we can change in the technology to fit what customers want. And that's our main motivation. The question of return on investment doesn't come into play here as much as what is, in this case, our motivation for opening the Continente Labs store.”* (Participant 7, SONAE)

- *“What I can tell you is: in terms of the Smart Store, we're still learning. We don't have a closed [business] model yet, not least because it's something that could go anywhere.”* (Participant 5, GALP)

- “*On one side, because people need this. I think it is something inevitable, it´s going to happen. It’s this autonomy that people need when they go shopping, I think it is very important*.” (Participant 2, SENSEI)

- “*We don´t know where we are going (...) We keep testing, we keep implementing, we keep observing, but maybe in five years, the experience is not the one we are showing today. ”* (Participant 8, SONAE)

Final Thoughts

We would be remiss if we did not finish this report by stating all the work that remains to be done. In 2025, as artificial intelligence dominates both the news and technological development, more must be done to investigate the worlds that are being created and changes that they will bring. Questions of agency, justice, equity, surveillance, privacy, data ownership, cybernetics and behavior manipulation should remain front and center. This means, at least, that more funding must be given to the social and human sciences to examine efforts that are too often portrayed as 'merely' technological or scientific.

We are grateful for the opportunity to do this work. We will continue examining the worlds of AS, even as the project comes to an end.

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Last but not least, we would love to hear from you! Please check out the project's website and get in touch with us!

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NOVAFCSH FACULDADE DE CIÊNCIAS SOCIAIS E HUMANAS UNIVERSIDADE NOVA DE LISBOA