

# NEW SENSES OF LOGISTICS

GIVE YOUR BUSINESS A **BOOST** WITH **SMART SENSORS**  
AND **SMART USE OF DATA**

White paper on new applications for sensors in logistics

*An initiative of DALI, a pilot project for logistics innovation in the supply chain*

# CONTENT

<b>1 PREFACE</b> .....	3
<b>2 THE PURPOSE</b> .....	4
Why are sensors so hot right now? .....	4
Logistical applications .....	6
Focusing on freshness .....	7
Containers in focus .....	7
Less forklift damage .....	7
Predictable maintenance .....	8
Green zone for trucks .....	8
<b>3 APPLICATIONS</b>	
The cost of sensors -	
How do you develop a business case? .....	10
Promising trends .....	11
<b>4 GETTING STARTED</b> .....	13
A roadmap .....	13
<b>5 CONCLUSIONS</b> .....	14

# 1 PREFACE

Sensors have long been used in logistics, for example to detect the movement of goods in a warehouse or to measure the temperature of a container. The emergence of smart sensors, Internet of Things (IoT) and artificial intelligence (AI) allows you to get much more from your data. The technology is affordable and even SMEs can benefit. What are some examples of successful applications? And how should you approach a sensor project?

## The DALI project

'Data Science for Logistics Innovation' is a pilot project to upgrade and future-proof data science in the logistics sector in the south of the Netherlands. The DALI project implements concrete data applications in the supply chain based on 18 business cases. Generic applications and tools are developed for the sector from these business cases. The DALI project intends to share the knowledge and experience acquired from the project with professionals and students in logistics and the supply chain. This white paper provides insight into state of the art of sensors in logistics and the supply chain, describes a number of specific sensor applications and provides a roadmap for getting started with a sensor project.

The DALI project is made possible by a contribution from the European Regional Development Fund in connection with OPZuid and by a contribution from Regio Deal Midden- en West-Brabant Makes and Moves.



# 2 THE PURPOSE

Businesses are under considerable pressure to improve their logistics performance. Customers want to receive their deliveries faster and more reliably, and to be well-informed. Competition is fierce and there is a lot of pressure on costs due to price transparency. These costs are, however, often unnecessary. According to Evofenedex, on average, logistics failure costs are as high as ten percent of company revenue! There are also other challenges: logistics personnel are scarce, CO2 emissions need to be reduced, and raw materials and energy are in short supply.

To overcome these challenges and make logistics processes as efficient as possible, reliable information is needed.

A great deal of information. Such as how many raw materials and items are in stock and where they are located? Which areas of a warehouse are congested? What is the precise location of a truck? What are the contents of a pallet? Where do delays potentially occur? And how can these issues be resolved? These are all questions that we can answer by making smart use of data and sensors.

Advances with regard to data and sensors are being developed rapidly. Whereas sensors were previously used to control the lights in a warehouse, today they are equipped with a chip and antenna and communicate via the Internet. Particularly in a field like logistics, where everything revolves around 'things' that move and the exchange of data, the Internet of Things (IoT) presents many possibilities. And the best part is: these applications are now available to you.

The purpose of the DALI project is to introduce SMEs to the added value of data-driven logistics. It does this by providing support and showing companies what is available on the market and how they can benefit. That is also the purpose of this white paper.

Offer inspiration, give examples and provide a roadmap of how to elevate logistics operations to the next level.

## Why are sensors so hot right now?

The first generations of sensors were simple devices capable of detecting light, registering physical movement or measuring temperature. The resulting measurement was converted into an electronic signal that could be used to set something in motion, such as turning on a light or opening a door. Nowadays, sensors are 'smart': they can store and interpret measurement data, perform calculations, make a diagnosis and are connected to a wireless network. In the Internet of Things, sensors can communicate with each other and make autonomous decisions on a limited scale.

A well-known example of the Internet of Things is the smart refrigerator with sensors that record how much milk is still in stock. A dumb sensor only registers how much milk is left. A smart sensor adds intelligence to this: it analyses how long it will take for the milk to run out, takes shelf life into account and even orders a new carton of milk from the online supermarket.

What makes sensors smart is not just the sensor but the whole ecosystem around it and the software that makes smart decisions based on data. Applications where this has been perfectly applied can be found in modern passenger cars, for example for detecting a flat tyre. If the tyre pressure drops from 2.4 bar to 2.0 bar in a 15-minute period, a 'Loss of Tyre Pressure' event is generated and a warning lamp comes on. If the tyre pressure drops from 2.4 bar to 1.1 bar in five seconds, this is a completely different event: a 'Flat tyre' and the car will actively intervene to keep the situation safe. Sensors are getting better, but the smartness is mostly in what you do with the data.

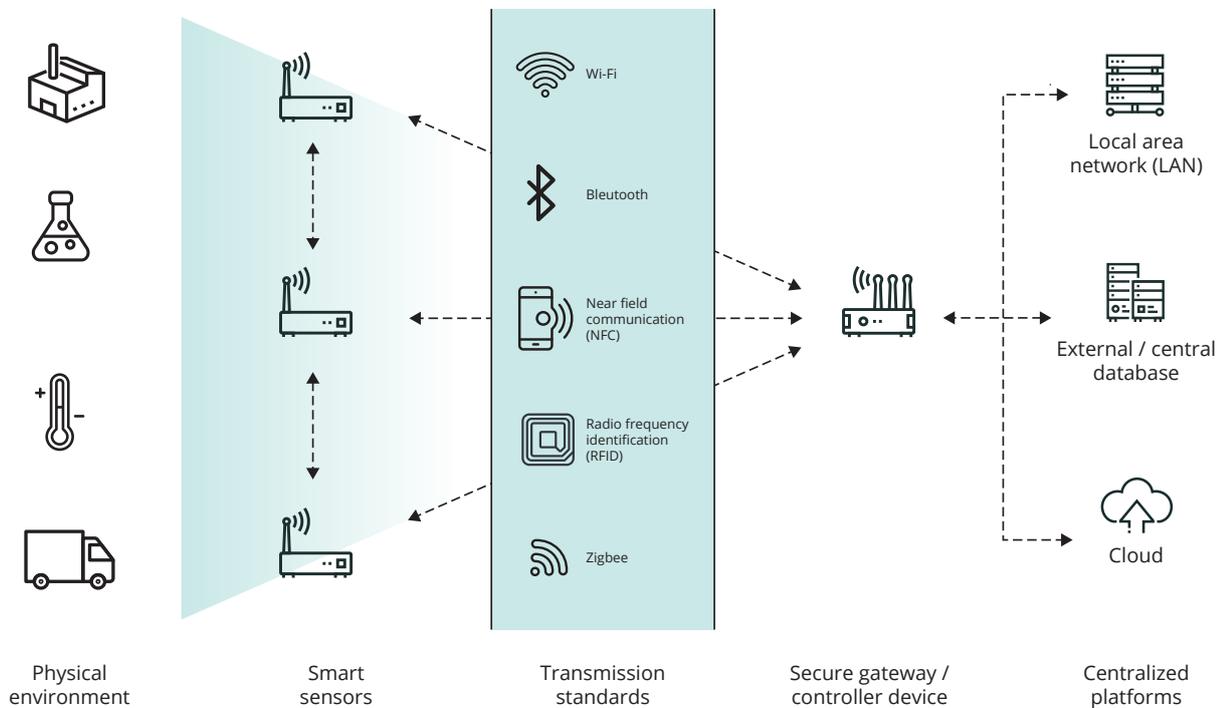


Figure 1. The ecosystem of smart sensors.  
 Source: This graph is from the highly recommended report 'Using smart sensors to drive supply chain innovation' by consulting firm Deloitte.

Besides being 'smart', sensors are also increasingly smaller, more energy-efficient and cheaper. The cost of IoT infrastructure, including hardware, connectivity and data platform, has become ten times cheaper in the course of a decade. Even better news is that for a logistics application, you often do not even need to buy new sensors because they are already installed in trucks, forklifts, material handling systems, etc. Did you know that the smartphones everyone has today contain as many as twenty sensors?

Great new applications in logistics can be created by making 'smart' use of this, such as transport man-

agement systems based on the location and speed sensors in the driver's phone.

The fact that telecom networks have become cheaper and many times more powerful also helps. WiFi hubs cost a fraction of what they once did and anyone who has ever taken out a smartphone subscription knows that you are getting more and more mobile data for less money. Moreover, the practice of paying for the entire sensor infrastructure or parts of it on the basis of a 'pay per use' model has become quite widespread. This means that as a company, you do not have to make an investment, but you pay a fixed amount per month

depending on the extent of your use of the sensors and the platform.

The good news for logistics companies is that data analysis techniques are increasingly better. Affordable business computers can process immense amounts of data and use artificial intelligence to recognise patterns in these data that the human brain has never noticed before. One sector that makes extensive use of this is e-commerce. By using data on customer search and ordering behaviour, online stores can accurately predict demand and thus optimise their inventories. Artificial intelligence is also used in self-driving cars that continuously analyse what is happening around them or to control a robot in a warehouse.

The use of artificial intelligence for analysing logistics data is no longer restricted to universities or large companies employing IT specialists. The IoT plat-

forms offered by companies such as Google and Microsoft are increasingly more user-friendly and available to all. The platforms provide functionalities to monitor sensors and automatically store data, make analyses and send commands back to devices. There are also good open source solutions on the market. In short, the developments surrounding sensors are favourable: sensors are becoming smarter, more economical and cheaper, and analysing data is becoming more accessible. These developments make its application in logistics more attractive than ever. This is the perfect time to use this technology in your business.

### Logistical applications

Technological developments surrounding sensors are favourable, but what can you do with them? The overview below shows the sub-areas of logistics where sensors are currently widely used followed by a few examples.

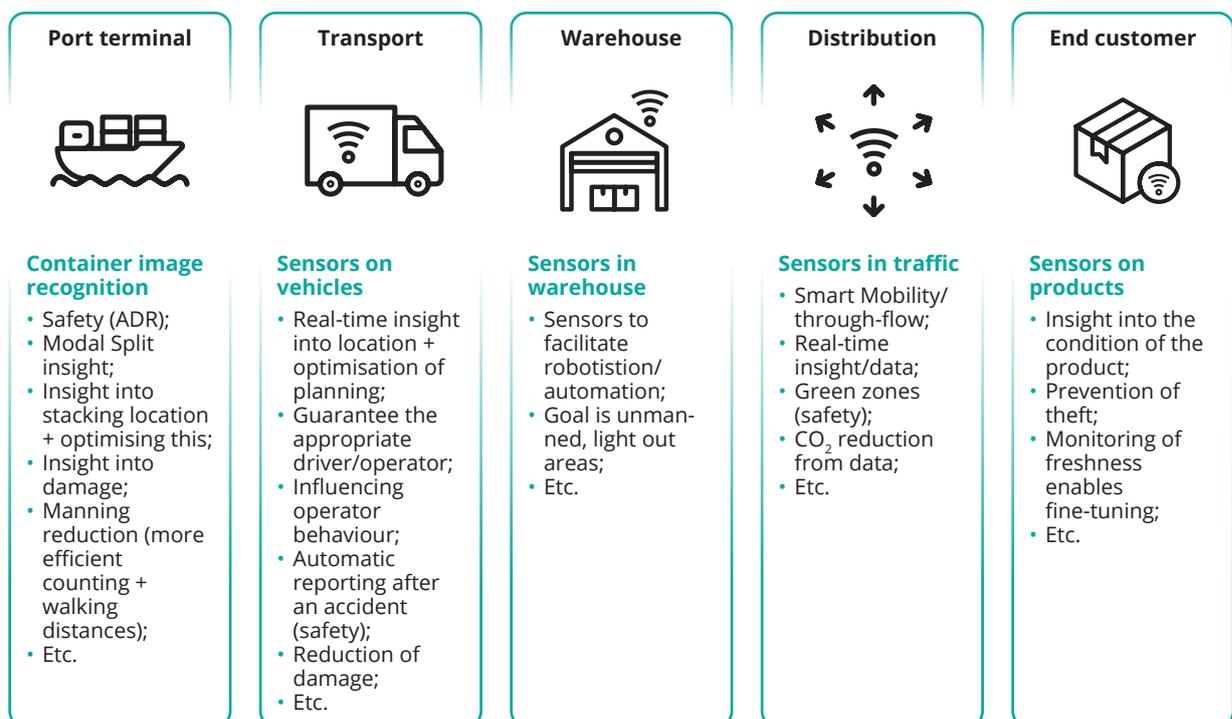


Figure 2. Applications of sensors in the logistics chain

### Focusing on freshness

Sensors have been used in the food industry for many years, such as to measure the temperature of fresh fruit and vegetables during transport. Transport companies use the data to show customers that their goods were transported under the proper conditions. But more can be done. The use of sensors to prevent quality loss and downtime was shown during an IoT project at food producer Van Oers United, under the direction of TNO. This makes it possible to increase sales by millions of euros.

On average, 21%\* of all fruit and vegetables are damaged between harvesting and the time they reach the shop. During the transport of green beans from Africa to the Netherlands, up to 15% of the fragile cargo is damaged and can no longer be sold. "Smart ethylene sensors allow you to follow the ripening process during transport," says Gerwin Zomer of TNO. "Based on real-time measurement data, transport planners can make adjustments, such as providing extra ventilation during stopovers, reducing the container's temperature or speeding up the transport time. Or they may seek alternative outlets for fruit and vegetables that are unlikely to reach the Netherlands without being damaged."

*\* According to the report of a study by the United Nations Food and Agriculture Organization "The state of food and agriculture 2019. Moving forward on food loss and waste reduction."*

### Containers in focus

Great strides have been made in the field of image recognition software; it is now possible to recognise objects and read inscriptions even with simple cameras. The firm Sentors in Breda has developed an application that automatically identifies containers. It is now used at a large number of container terminals. The system not only records the number

of incoming and outgoing containers, but also whether they contain any hazardous substances. This ensures a significant increase in efficiency and a reduction in errors during loading/unloading operations. If a container is damaged, the images are available so that the damage can be dealt with faster and more fairly.

According to founder Sander Maas of Sentors, image recognition in logistics presents a wide range of possible applications. "We developed an application for a construction company that uses cameras to count construction equipment. This means that you need to perform fewer manual actions and the reliability of your stock inventory increases. This eliminates the need for the company to purchase all kinds of equipment unnecessarily. While stock-taking in warehouses is generally carried out using scanners, objects outside the warehouse such as scaffolding planks and props do not have barcodes."

### Less forklift damage

Forklift trucks contain a lot of electronics such as an on-board computer, PLCs that control motors and movements and sensors that measure speed, acceleration and braking.

IoT service provider Key2asset has developed a platform that can unlock this forklift data and link it to the access card or mobile phone of the employee. The forklift 'recognises' the employee and only starts up when all conditions are met, such as: Is the driver actually on duty at the moment? Or: Does he have the required certificates? The platform can also be used to record driving performance and distances travelled.

The Key2asset IoT platform is used by forklift truck manufacturers such as MotracLinde and Mitsubishi who offer it to their customers. "The great thing about IoT is that you discover more and more new

advantages as the project progresses,” says CEO John Versmissen of Key2asset. “We first started using our platform to predict necessary maintenance of forklift trucks, but since then we have discovered 35 other cost-saving applications. One of these is damage reduction through the use of motion sensors that register abnormal driving behaviour or collisions. Among companies applying this, claims were reduced by as much as 80%.”

### Predictable maintenance

At Tata Steel in IJmuiden, smart sensors are used to predict when maintenance on machines is required. To function properly, hot strip mills need to be lubricated 24/7. If a pipe becomes blocked, the production line has to be shut down, costing several thousand euros per hour. In the past, a maintenance engineer would walk through the entire plant every day to check that the oil was still flowing properly through the pipes. An analysis by consultancy firm Perfect Group revealed that a blockage in the oil supply can also be detected by means of a temperature measurement: if hot oil is no longer flowing, the temperature of the pipe decreases.

A relatively simple system with temperature sensors was found to be the best solution for identifying in good time when the lubrication system should be

serviced. Through the installation of the sensors on the pipes and having them communicate wirelessly with a web-based analysis tool, the maintenance engineers at Tata Steel were able to gain remote online insight into this crucial process.

As a result, manual inspections can be dispensed with, there is less wear and tear on machines and there are fewer breakdowns. This led to a reduction in maintenance costs and an increase in productivity of hot strip mills.

### Green zone for trucks

In the context of traffic, sensors are already widely used to measure movements of cars or cyclists at crossroads, but GPS data from on-board computers and mobile phones also provide a lot of insight. This makes smart mobility possible, where travellers can plan and replan their journey based on real-time information, book a shared bicycle or car, or find the nearest available parking space. “Data is the new fuel,” says Paul Potters of Monotch, which offers a unique platform comprising all data on traffic movements, traffic lights, parking spaces and barriers in the Netherlands. Many applications have already been developed based on this, such as the parking app of the ANWB and the Flitsmeister app that warns of stationary trucks along the road.





Monotch participates in the logistics projects 'Talking Traffic' and 'Talking Logistics'. These projects include using traffic lights to create a green wave for ambulances, police and fire brigades so that they reach their destinations faster and cause less traffic disruption. GPS data is used to calculate when a car with siren is approaching an intersection and proactively turns the traffic lights green. Potters: "Similarly, you can create corridors for freight traffic carrying hazardous materials. Public authorities want to restrict the movement of this freight through the city; via Talking Logistics you can arrange for certain vehicles to enter a port area or terminal by means of a green wave."

Another current project in this area is Connected Transport Corridors by Smartwayz, a government-initiated mobility programme that is intended to make transport more efficient, sustainable and safe.

**Cora van Nieuwenhuizen**, former Minister of Infrastructure and Water Management said;

*"We have an advanced, high-quality infrastructure in the Netherlands. We have smart traffic lights, an excellent telecom network, a strong logistics and IT sector and a huge amount of data. If we combine all of this and make use of the benefits of controlled data sharing, we can get a much better handle on our logistics traffic and thus improve its efficiency, traffic safety and flow." The applications developed by the project are available on the logistics data portal Deflog ([www.deflog.org](http://www.deflog.org)).*

# 3 APPLICATIONS

Application of sensors - the benefits at a glance The logistical applications of sensors and the wealth of data they provide are virtually endless. Technology is constantly evolving and every day a new feature is discovered by a company somewhere. The following are the key benefits:

## **More efficient processes:**

- Counting stock or checking orders no longer has to be done manually. This saves staffing costs and reduces the risk of human error.
- Processes can run faster because information is available more quickly and remotely.
- Errors are detected more quickly which prevents failure costs.
- Recording damages saves costs and discussion during the handling process, such as in the case of a dispute about damaged containers.

## **Better delivery performance:**

- Sensoring increases stock reliability, prevents mismatches and leads to higher delivery reliability for customers.
- Reliable stock can be replenished more accurately, reducing the need for safety stock.
- Monitoring environmental conditions such as temperature and humidity reduces waste and improves reliability for clients.
- Products tracked by sensors are less likely to get lost and result in lower depreciation costs.

## **Increased uptime of machines:**

- Sensoring increases the uptime of machines, trucks or material handling systems because failures are identified in advance and can be prevented.
- Sensoring leads to lower maintenance costs because manual inspections are no longer necessary and expensive repairs are avoided.

## **The cost of sensors -**

### **How do you develop a business case?**

The implementation of sensors and the associated ecosystem obviously requires an investment, whether purchased outright or on a pay per use basis. Companies want to recoup these costs and the issue is therefore: What form should a business case for a sensor project take?



## **The costs**

In general, there are two types of costs involved in a smart sensor project: one-off installation costs, which are mainly for hardware and the man-hours to set up the application, and recurring costs, which are mainly for the software platform and its operation.

How high the costs are depends on the amount and type of hardware, particularly the extent to which the application must be made specifically for your

business, according to Sander Maas, CEO of Sentors. "The cost of equipment for a camera and PC suitable for outdoor use starts at around €2,500. In addition, we will need to spend some hours customising the solution to your location.

We can keep these costs down because we have standardised container recognition as much as possible. We have created integrations with the most commonly used planning packages and have developed an in-house web portal that archives the corresponding photo/video recordings for each container. The costs will be higher if you need more cameras and lighting or want to add more image recognition tasks." You should also look at the Total Cost of Ownership rather than the one-off investment, emphasises Tom Heijnen of SenseAnywhere, a supplier of smart temperature sensors that are widely used in the pharmaceutical and food sectors. The sensors search for the nearest access point during transport and use it to transmit their data to the cloud platform. Heijnen gives a mathematical example of the costs: "The sensor we supply costs around €150. That may seem a lot, but they last for ten years without needing to be recharged or maintained. A receiver for an access point in a warehouse costs around €200, and one for a truck is around €500. The use of our cloud service where you manage your data and your notifications is on a subscription basis. When you factor all of that in, an average implementation costs about €3 per month per sensor. That is the amount you should include in your business case."

### **The business case**

The costs and benefits will vary from project to project. To illustrate this, we provide the business case created for the aforementioned IoT project at Van Oers United specifically for the transport of green beans from Morocco to the Netherlands. For this purpose, the research organisation TNO has calculated what the revenues and costs per container of green beans would be.

Revenues: By monitoring the quality in real time and taking targeted action during the logistical process, Van Oers United can improve freshness and thus increase sales. TNO has calculated this and found that there are additional revenues of €8,000 per container.

In terms of costs, the following expenses must be incurred:

- Hardware and sensors (ethylene, temperature, CO<sub>2</sub>, oxygen and humidity)
- Use IoT software and cloud solution
- Communication network costs
- Developing a model for interventions
- Costs of the interventions themselves

Depending on the type of intervention, TNO calculates the total cost at between €1,200 and €2,500 per container.

In other words, this project enables the food company to generate €8,000 - €2,500 = €5,500 more profit on each container of green beans.

The full calculation of this business case plus more information on the IoT4AGRI project can be found on the Smartport website:

<https://smartport.nl/downloads/>

### **Promising trends**

In this white paper, we highlight the fact that smart sensors are already being applied in logistics in various places. But there are many more developments in the pipeline. By way of inspiration, here are a few examples of start-ups that are working on this.

### **Parking sensors for trucks**

Parking sensors for truck-trailer combinations that, when reversing, give a warning signal if an object is in the way. Although such sensors seem fairly obvious, Max de Feber of Tilburg-based Boost-physics says that the optimal system did not exist. So the company developed a practical solution

consisting of ultrasonic sensors on trailers that connect wirelessly to a module in the truck cabin. This has the advantage that it always works; the sensors and the module make contact automatically and the driver does not have to do anything manually.

According to De Feber, there are many more potential uses for the measurement data collected by the sensors. "We have made the module on the trailer internet-connected so that we can collect and analyse all the data centrally. This can also be used to develop other applications, such as a tool that predicts the locations where there is an increased risk of collision and proactively warns the driver of this. But transport planners can also benefit from this by planning the most suitable trailers for high-risk loading or unloading locations, such as one with a short turning radius."

#### **Conditioned transport and smart contracts**

Conditioned transport is often subject to regulations and contract agreements. For example, a logistics service provider must be able to demonstrate to the transporter that the products have been kept at the desired temperature, humidity and shock resistance. Sensors can be used to prove this, but there must be clear agreement on how this is to be recorded. This can be a complex matter with a lot of red tape, especially in international transport where many parties are involved. Sensor data must be stored in a standardised manner so that parties can objectively assess whether the other has complied with the agreements.

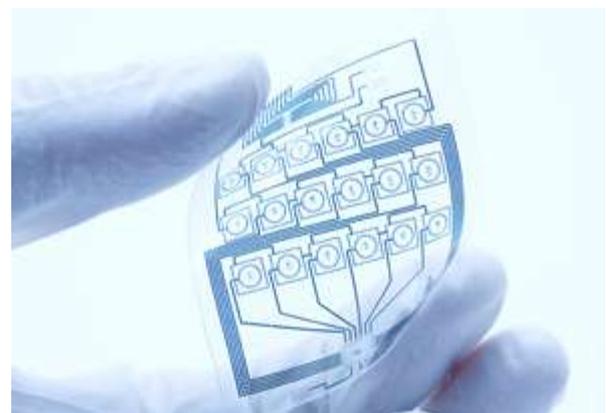
2bSmart of Tilburg has come up with a solution based on blockchain technology. "Our platform can be used to facilitate smart contracts," says chief technology officer Robert Rongen. These are digital protocols that ensure that a contract is automatically executed when the agreed criteria are compared to the measurement data. "If a logistics party delivers a

shipment of refrigerated items and the measurement data from the sensors is in our system, the administrative processing, invoicing and payment can be initiated automatically."

#### **Smart packaging**

A potentially interesting sensor application is the printing of products with electrically conductive inks that can measure chemical processes. Graphics company Metafas in Asten is pioneering this and has developed smart medical packaging together with other companies. For example, the printed sensors can identify when a blister is broken and transmit this to a smartphone or computer. This will facilitate the development of a reminder app for patients so that they take the correct medications on time every day.

"The technology for smart packaging can reduce waste in hospitals," says Metafas Group founder Hans van de Mortel. "Currently, there is little tracking of which medicines, disposables and implants are actually used and how much is thrown away. Printed sensors that register when packaging is opened make it possible to monitor actual consumption, which reduces the need for stockpiling. This is benefits suppliers who deliver on consignment. When the smart package is opened, the supplier can automatically send an invoice."



# 4 GETTING STARTED

## A roadmap

Are you enthusiastic and do you intend to start working with smart sensors? Below are the steps you can take to enable your business to benefit from the opportunities that smart sensors can provide.

- 1** Be inspired. Take a look at other companies, visit conferences, talk to experts and join knowledge platforms like Logistics Community Brabant. Collaborate with educational institutions and allow a work placement student to study the potential applications of sensors.
- 2** Make a shortlist of the application areas where sensing could bring business benefits. Examine processes where there is a financial benefit, such as because there are high costs involved if these processes are shut down. Also identify the application areas where staff want to be involved in the project. In the beginning, it is mainly pioneering and learning and you need staff who enjoy this.
- 3** Check what sensors you already have and what data is available. Do not forget about the data collected elsewhere in the supply chain that you can make use of as a partner in the chain. Investigate whether you can achieve business benefits using that data; many companies already use sensors in their logistics processes in one way or another. There are also platforms such as Deflog that collect this information and make it accessible in a standardised manner.
- 4** Talk to chain partners to see which initiatives already exist and which ones can be undertaken jointly.
- 5** For small to medium-sized companies, the advice is to start small and gain experience with sensors through pilots or student work placements.
- 6** Do not buy everything yourself but use 'sensing as a service'. This has the advantage that the initial investment is lower and you can get started more quickly. You also benefit from the know-how of the SaaS service provider. The disadvantage is that you can develop fewer company-specific applications. Increasing numbers of suppliers offer a menu structure that involves purchasing the sensors yourself, for example, but using a cloud-based IoT platform for data processing.
- 7** Find the right partners/suppliers. The implementation of an Internet of Things platform requires specific know-how in many specific areas that hardly any company has in-house. That is why it is important to connect with the right partner from the start.



- 8 Start with a pilot, then potentially scale up and standardise. See what works in small iterations; do not simply follow an old-fashioned waterfall route, because at the outset you do not know what you have and what you can do with it. If several sensor pilots have been successfully implemented in a company, it is important to bring everything together in a single platform and to link up with a new standard for future projects.
- 9 Never invest in new technology without taking a critical look at your processes and the structure of your organisation. The use of smart sensors offers great opportunities but will also lead to changes in your business. Prepare for this and ensure that processes always remain in sync with the IT systems.
- 10 New technology and changes may trigger resistance in your organisation. Prevent this and actively engage in change management. Involve employees and make them understand why you are investing in sensing and the added value for the organisation and for them personally.

## 5 CONCLUSIONS

Perhaps this white paper has started you thinking about boosting your business with the help of intelligent sensors. We hope that the examples and tips listed here will be helpful to you. Do not hesitate to contact us if you have any questions. One more time: find the right partners. All the companies and organisations mentioned, whose addresses and websites can be found on the reverse side, are more than willing to support you in your quest for optimal logistics operations. Today's technology is in a perfect storm ... now is the time to act.

## Would you like to know more?

**Dali.lcb.nu**

Alternatively, please contact:

### **Logistics Community Brabant**

campus Breda University of Applied Sciences - Grensgebouw

Mgr. Hopmansstraat 2

4811 DK Breda

Email: [info@lcb.nu](mailto:info@lcb.nu)

Tel: +31(0)76-5332645

[www.lcb.nu](http://www.lcb.nu)

We are happy to assist you.

### **Author**

This white paper is written by Harm Beerens, a copywriter and journalist in the field of logistics and supply chain management. Harm was previously the portal manager of Logistiek.nl and a community manager at knowledge association IMCC. He is currently a freelance content specialist and writes for publications such as Supply Chain Magazine. More information about his work can be found at: [www.harmbeerens.nl](http://www.harmbeerens.nl)



This project is made possible by a contribution from the European Regional Development Fund in connection with OPZuid and by a contribution from the Regio Deal Midden- en West-Brabant.

Many companies and individuals have selflessly contributed to this white paper. We thank them for their contribution and for sharing their knowledge and experience. For more information, see the full list and websites below.

**Logistics Community Brabant**  
[www.lcb.nu](http://www.lcb.nu)

**DALI (Bas Groot)**  
[www.dali.lcb.nu](http://www.dali.lcb.nu)

**TNO (Gerwin Zomer)**  
[www.tno.nl](http://www.tno.nl)

**CGI (Hans Moonen)**  
[www.cgi.com](http://www.cgi.com)

**Sentors (Sander Maas)**  
[www.sentors.nl](http://www.sentors.nl)

**Key2asset (John Versmissen)**  
[key2asset.com](http://key2asset.com)

**Monotch (Paul Potters)**  
[monotch.com](http://monotch.com)

**Sense Anywhere (Tom Heinen)**  
[www.senseanywhere.com](http://www.senseanywhere.com)

**Boostphysics (Max de Feber)**  
[www.boostphysics.com](http://www.boostphysics.com)

**2bsmart (Robert van Rongen)**  
[2bsmart.eu](http://2bsmart.eu)

**Metafas (Hans van de Mortel)**  
[www.metafas.nl](http://www.metafas.nl)

**Deflog**  
[www.deflog.org](http://www.deflog.org)

