Proceedings of 7th Transport Research Arena TRA 2018, April 16-19, 2018, Vienna, Austria

URBANWISE: efficient urban deliveries by means of an IT platform

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Abstract

Large quantity of goods and services need to be available in urban areas, where numerous people get together. Urban freight transport, for commercial and domestic purposes, account for 20-30% of total traffic volume. All people involved (authorities, companies, residents….) face challenging problems which at its best can be seen as symptoms of a vibrant city: traffic congestion, negative environmental impact and high energy consumption. Up to 40% of the total logistics costs can be attributed to the last mile of goods transport. It is high time to implement smart solutions… like the IT-platform URBANWISE. In this paper we focus on one of the modules, URBANWISE Construction.

Keywords: IT-platform; freight transport; mobility in smart cities; construction sector.

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1. Introduction

URBANWISE is a research project from Belgian research institutions (Qalinca Labs, BRRC, BBRI and Multitel), teaming up from 2015 to 2017. It is the only selected project within the framework of 'WB Move', a research program in the field of mobility, transport and sustainable development. This program is part of a common strategy of the Walloon region, Brussels-Capital Region and the Federation Wallonia-Brussels for the development and investment in research.

URBANWISE aims to design, develop, validate and evaluate an open platform for communication and management for urban logistics. It strives to make city logistics smarter, with

- Better planning and monitoring of deliveries, via further integration between actors involved;
- Implementation of consolidated deliveries by offering all stakeholders the opportunity to exchange on needs and offers of transportation services;
- Promotion of new urban logistics services through the creation of a virtual marketplace for city logistics.

In practice, URBANWISE aspires to connect all actors of urban logistics, whatever the sector, company size, its role in the supply chain (carrier, receiver….), and its type of IT tools in use. The URBANWISE platform is tested across several sectors (urban construction logistics, cargo cycle deliveries), with attention to three types of interfaces: web interface for SMEs (with a lack of logistics software); system interface for companies that already use logistics software; mobile interface for mobile users (couriers, transporters…).

In this article we will present the main facets of the research so far conducted, and give an outlook for future developments and perspectives. Chapter 2 will explore the role of IT systems in city logistics, and the state of art of existing IT solutions for logistics. This allows us to focus on opportunities for SME oriented solutions, especially for the construction sector (building and roads) and the light freight sector. The analysis of the needs for the construction sector is discussed in chapter 3. Chapter 4 will present the platform architecture and its development. Finally, chapter 5 mentions the validation and future of the URBANWISE construction, going from a promising tool to a fully operational IT-platform.

2. Sustainable City Distribution and IT

2.1. What is the problem?

Due to their large populations and extensive commercial establishments, urban areas require large quantities of goods and services for commercial and domestic use (Browne et al., 2012). Therefore, an efficient and environmentally friendly urban goods transport system is essential for the economy and liveability of cities (OECD, 2003).

According to different sources, urban freight transport accounts for 15-30% of vehicle kilometres in urban areas (Dablanc, 2007; Kenworthy et al., 1999; Russo and Comi, 2012; Schoemaker et al., 2006). However, due to the specific conditions in which urban deliveries are performed, urban freight transport presents disproportionally high external impacts (Lebeau, 2016). Indeed, urban freight transport faces many challenging problems, including high levels of traffic congestion, negative environmental impacts, high energy consumption (Taniguchi et al., 2001). Moreover, although freight transport in cities constitutes a small proportion of the total freight transport length, it generates a high proportion of the cost, with 'last mile' accounting for 28% of the total cost of transport (Wittlöv, 2012). Economic impacts also include decreases in journey reliability and impact on congestion (Quak, 2008). Decreased accessibility and reliability leads to the reduction in levels of service and efficiency of freight transport (Taniguchi et al., 2004).

2.2. Instruments

Numerous instruments are available to remedy difficulties in the organization of freight transport in cities and to reduce its negative impacts, numerous instruments are available (table 1).

Table 1. Available instruments for urban freight transport

Instruments	Example(s)
measures relating to physical infrastructure	establishment of urban distribution centers or new loading and unloading infrastructures
administrative and regulatory measures	access restrictions in the urban area depending on the size of the vehicle, its environmental impact or delivery schedules
economic measures	traffic taxes or subsidies granted to "green" operators
educational measures	awareness campaigns or eco-driving training for drivers
measures related to spatial planning	establishment of new logistical areas
technical measures relating to vehicles	use of compressed natural gas (CNG) vehicles / electric vehicles
technical measures related to information technology	IT Platform, Transport Management Systems (TMS)

All the instruments are key elements of a sound freight transport policy. However, we believe that in particular IT solutions have a great capacity to solve some of the organizational problems in urban logistics.

2.3. IT systems in sustainable city distribution: role and possibilities

First, they can improve the dissemination of information on spatial and temporal constraints in urban areas, thus optimizing transport flows, avoiding inaccessible areas or obstacles, or allowing carriers to identify free delivery locations. IT systems would allow better management of road space via reservation systems.

Secondly, information systems allow for better vertical synchronization between actors. It is thus possible to remedy certain difficulties in shipping and receiving (deliveries not completed due to absence of recipient, several vehicles that load or deliver simultaneously, etc.). For example Debauche (2006) shows that 25% of deliverers don’t notify merchants of the delivery date / time.

Thirdly, information systems can allow for horizontal collaboration between actors. The vehicle loading rate can increase by pooling cargo. The basic idea of urban cargo pooling is that the volume of freight vehicles in urban areas could be reduced through more efficient use of vehicles (higher average load factors, fewer empty trips) (Crainic and Gendreau, 2003). The purpose of cargo pooling is to combine individual shipments, groupings or partial shipments destined to the same locality in a consolidation center so that fewer complete cargoes are transported to their destination (Lewis et al. 2007). Physical pooling is a common approach, which involves introducing a transhipment point where shipments are recombined. The most well-known measure is the establishment of urban distribution centers, a popular measure in urban logistics (Verlinde et al., 2012).

However, mutualisation does not necessarily require the introduction of a physical pooling platform, but can be achieved by a change in behavior (Verlinde et al., 2012). This forms the basis of collaborative logistics systems. Sharing of information on available capacities would allow a shift towards such systems. Indeed, the emphasis of companies should no longer be on the optimization of the use of their assets but on the optimization of the delivery, using available assets, whatever their owner (Mervis, 2014).

Fourthly, IT systems can contribute to the promotion of new sustainable urban logistics services. The adoption of these new logistical schemes remains a challenge: transport companies lose visibility on the terminal subcontracted part of deliveries, which can have a direct impact on the quality of service (e.g. communication failure about the exact position of the package). Similarly, the development of these new services is constrained by the ability of new entrants to communicate on their transport offer, thus capturing sufficient flows necessary for the creation of a profitable service.

2.4. Existent IT solutions for city distribution

A state of the art regarding IT tools currently available for urban logistics is relevant for the URBANWISE platform. With this knowledge we are prepared to explore the needs (especially for two sectors we focus on, construction and light freight), allowing us to judge the potential of new services.

2.4.1. Transport Management Systems (TMS)

TMS have played a role in the smooth functioning of the supply chain since the 1980s. Such systems are generally available as stand-alone software packages, often as part of an Enterprise Resource Planning (ERP) system (PRG - Oracle, 2014). TMS are primarily intended for carriers or service providers whose core business is to provide transport and logistics (packages, containers, bulk goods) on behalf of their customers. For these carriers, TMS covers functions such as scheduling of delivery, optimization of rounds, optimization of loads, and real-time traceability. However, most of the transport management systems currently available are primarily targeted at large companies and do not adequately address the needs of SMEs. SME's often lack resources to implement a TMS, requiring a long process of integration and customization, (EASME, 2015).

2.4.2. Data exchange standards

Resource management in the supply chain is increasingly computerized within companies, with tools as Enterprise Resource Planning (ERP) or Warehouse Management System (WMS). However, these tools are not able to communicate with each other. For a long time, these expensive and heavy to use tools were reserved for large companies. The emergence of more flexible cloud computing solutions is beginning to arrive on the market. Next, harmonized tools for the exchange of referential data between a supplier and its customers (identification and product description data) have been created, such as standardized electronic catalogs.

Recently, a range of new standards has been developed for the harmonized exchange of event data between all actors in a supply chain. These standards have been created specifically to provide a shared visibility between the various operators of the supply chain. This visibility is based on 2 pillars:

- identifying the logistic units, i.e. creating a link between an identifier and an object, a package or a palette, in order to generate the information flow associated with the physical flow,
- to collect, exchange and share unified information through standards common to all players in the supply chain, using tools that create data in the same formats, independent of the technology used: 1D barcode, 2D barcodes (QR code, Datamatrix, ...) or RFID tags (radio frequency identification).

This family of standards, grouped together under the name EPC global (Global Electronic Product Code), was developed by GS1, an international standardization body whose role is to facilitate the exchange of information between players in world trade. This includes identification standards such as the EPC (Electronic Product Code) and interface standards such as EPCIS (Electronic Product Code Information Service).

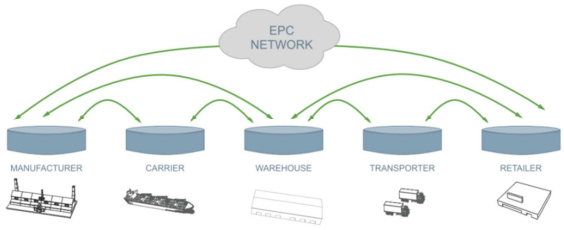

Fig. 1 Schematic description of EPC network coverage (Ecologistics, 2013)

EPCIS allows tracing the complete life cycle of a product, from the producer to the consumer (see fig. 1). This standard provides communication interfaces allowing the interconnection of independent traceability databases. Users are free to develop their own architectural system, according to their objectives, with hardware and software components of their choice. Such harmonization allows the interoperability of the tools, allowing partners to keep applications they use (ERP, WMS…), with their own data and vocabulary. Also, it allows exchange security, where each actor is master of his data, and only shares them with the partners he has chosen.

2.4.3. Mutualisation of transport: freight exchange platforms

Freight exchange platforms are platforms for the exchange of information between carriers and shipping companies to facilitate and accelerate decision-making in the transport industry (Lewandowski, 2014). It allows

the various actors to find or to provide missions of goods transport for the account of others (Rakotonarivo et al., 2009). Freight exchanges allow carriers to limit empty shipments, to optimally use their cargo space, to acquire new transport commissions which results in lower costs for services (Lewandowski, 2014). Current available freight exchanges include BP2WEB, TELEROUTE, TIMOCOM, TRANS.EU,WTRANSNET (Huyghe, 2014). Currently, these freight exchanges focus on inter-urban long-distance transport rather than on urban logistics.

2.4.4. Mutualisation of transport: crowdshipping

Crowdshipping is part of a larger trend in the "sharing economy" (Arslan et al., 2016). It transforms ordinary citizens into transporters through the creation of new logistic networks (McKinnon, 2015). People travelling from A to B can take packages to be delivered for a fee. The package can then be brought to very low marginal cost in economic and environmental terms (McKinnon, 2015). Among the crowdshipping platforms we can cite Zipments, Friendshippr, PiggyBee, Bringrs, Roadie, UberCargo. A number of these platforms focus on local delivery (eg Postmates, Deliv, Doordash, Swapbox). Finally, we can also note the emergence of some platforms that allow pooling of storage locations according to the same principle. Examples of such platforms are Lockitron, MakeSpace, Boxbee, Cubbyhole, Parcel Pending, ShareMyStoragee and Roost (Accenture, 2015).

However, in spite of the interesting potential of these initiatives, crowdshipping involves several additional risks compared to deliveries by logistics professionals: an increased risk of damage and loss of packages, higher security risks and a guarantee of quality of service that is not always present (McKinnon, 2015).

2.5. Information tools and urban management

Next to these IT-tools for city distribution, initiatives aiming to improve information and urban management are worth mentioning. These tools are potentially linked to some features of the URBANWISE platform.

2.5.1. Network information

Cities can provide traffic information on the network, in an attempt to improve transport planning and vehicle routing. Many routing and navigation tools are available but few take into account the characteristics of urban logistics such as different access regulations depending on the size of the vehicle, time of day. However, we can highlight initiatives the following tools specifically designed for urban logistics:

- Some cities have developed preferential routes for truck traffic and have integrated them into GPS navigation tools (e.g. in Bremen, Tallinn or in the Ruhr region) (SUGAR, 2011);
- For London there exists an on-line travel planner specifically designed for freight transport, taking into account regulations for vehicles of different sizes.

Optimal vehicle routing also requires that real-time information is taken into account in the event of any disturbance. The Belgian research project Urbanzen provided a collaborative solution, with network information coming jointly from both drivers and authorities, integrated in a transport routing tool. Despite the strong interest in this project it was (not yet?) implemented, basically due to insufficient financial support from (local and regional) government support.

2.5.2. Management of delivery areas

Another type of initiative concerns the management of delivery areas. Two interesting projects are the FREILOT project, which has set up a booking system for delivery locations in Lyon and Bilbao (Gonzalez-Feliu et al., 2013), and Aires of Future Delivery (AFL) project in Lyon, which improve the use of delivery areas by means of booking and dynamic adjustment (PREDIT, 2013).

The projects show that the use of intelligent management systems and booking of delivery locations can rationalize their use and drastically reduce the number of illegal parking (up to 80% reduction depending on the type of vehicles), while offering more comfort to drivers. However, it should be noted that there is a need for a real-time dynamic reservation system. Indeed, as it is difficult for carriers to plan in advance the time of arrival, a reservation too early could be counterproductive.

3. Needs for the construction sector

3.1. Process

In parallel with the state of the art of IT systems in sustainable city distribution and urban management systems, we entered into dialogue with the industry to meet the needs for the URBANWISE platform. Initially, we analyzed four possible development directions: “construction”, “light freight”, “consolidation” and “smart cities”. Halfway through the project, URBANWISE was reviewed by international experts. Based on the progress and opportunities within the three year timescale of the research on the one hand we focused on the two most promising sectors for a new IT platform, “light freight” and “construction”. In this article we highlight the construction sector (roads and buildings), selected for the potential to match the traditions in the sector to the digital revolutions, and to provide smaller companies with the same type of capabilities as the larger companies.

A thorough consultation process made sure we develop what is needed. A preliminary study of the problems encountered by the sector and possible solutions was carried out. A total of over 50 meetings were held.

- Internal meetings, to make sure the needs for the sectors were fully understood by the IT development partner and to check the technical possibilities of potential developments of the IT-platform.
- External meetings were in the first place bilateral meetings. In this way, companies were able to speak freely without the risk to make competitors wiser than necessary.
- Later in the process we organized thematic workshops, in which we confronted the developments within URBANWISE to a panel of interested companies in the two selected sectors.

3.2. State of the art - construction

Concerning the state of the art in construction, two axes were examined: the internal organization of companies (suppliers, contractors, etc.) and the communication between companies.

3.2.1. Internal organization.

Computer tools allow suppliers of materials to plan and optimize their delivery rounds. In general, it was noted during our interviews with actors in the field that they have a very strong desire to optimize the filling of their trucks and to optimize their delivery rounds. This is irrespective of whether or not the IT tools are used, or the size of the company. This is due to the fact that we are in a highly competitive market and that the survival of the company is at stake. Consequently, beyond the environmental or mobility reasoning, it is mainly the economic criterion that encourages the suppliers of materials to plan and optimize the organization of their tour.

Concerning construction contractors, the organization of deliveries of materials are conditioned mainly by the planning of the construction site. There are a multitude of IT tools available to organize the execution of a construction site, to plan the delivery of materials, to follow up customers and to computerize a whole series of procedures in general. It should be noted, however, that there is a great heterogeneity between the construction companies vis-à-vis the computerization of their procedures and the digitization of information. Indeed, while most large and medium-sized enterprises have an integrated IT system, the smallest entrepreneurs are not sufficiently aware of these planning tools and their potential. The whole sector is not equally aware of the existence or the interest of the methods of management and planning.

3.2.2. Communication between companies

We have seen that each actor can have powerful tools in order to organize its internal activities. However, it was found that most of the problems encountered in delivering materials on site were due to problems of communication between the various actors on the construction site. De facto, calls for delivery of contractors are currently made either by telephone, or by e-mail or even by fax. Given the delivery constraints linked to the actual status of a construction site it is clear that there is a lack of information for smooth and optimized deliveries of construction materials. To our knowledge, there is no tool to consolidate communication throughout the delivery process between contractors and suppliers. URBANWISE would fill this vacuum.

3.3. Transversal needs

The construction sector has specific needs. Nevertheless, there are some transversal requirements, also in other sectors (like light freight). Future users see these as 'conditio sine qua non' for the development of the platform:

- There is a need to differentiate user accounts (linked to a natural person) and enterprise accounts. Different people in a company may have different responsibilities and access to the platform;
- All actors stressed the need to have a user-friendly and easy-to-use platform. It should be adaptable to all sectors of urban logistics and to many types of actors;
- As the platform aims to connect urban logistics players, there is a need to limit risks associated with setting up these new collaborations, it is necessary to verify some data and documents allowing authentication and guaranteeing reliability;
- Protection of company data remains a major element for the adoption of a new IT tool. URBANWISE must allow users to easily manage the confidentiality settings.

3.4. Specific needs in a heterogeneous sector

The construction module should help to improve the efficiency of the supply of construction sites and the disposal of waste and materials. It addresses the main actors in the building and roads sector (contractors, suppliers, collectors, transporters….). Through better communication between all these stakeholders, URBANWISE Construction aims to accompany all these players in the preparation of deliveries, monitoring of transport, management of unloading and disposal of waste. How to do so in this extremely heterogeneous sector?

- Multiplicity of actors

The sector is characterized by the multiplicity of its actors. Contractors, subcontractors, suppliers, transporters and collectors are all involved in managing the inbound and outbound flows of a site, each having a greater or lesser impact on the activities of others. Coordination and communication is fundamental to ensure smooth and efficient logistics. Our bilateral interviews showed that general contractors had very little visibility on the deliveries made by their subcontractors, resulting in a series of difficulties in the management of unloading (road congestion caused by unanticipated simultaneous deliveries, non-available unloading machines, etc.).

- Company size

The construction sector is distinguished by a wide variety in terms of company size, from the small craftsman working on his own account to the large multinational employing several thousand people. This heterogeneity has many implications for the way the sector operates, in particular on the level of computerization of companies and their capacity to use new tools and digitize their procedures.

- Nature of work

It is also symbolized by the nature of the work carried out. Construction supply is not handled in the same way by a large construction company or a company specialized in a technique. The nature of the work, and therefore of the materials, implies very different constraints in terms of delivery times, conditioning of the materials to be delivered, transport conditions (truck size, truck type, dimensions, weight , quantity to be delivered, etc.) or unloading conditions (type of lifting gear required, availability of these gear, delivery schedules, etc.). Therefore, good coordination and communication are once again fundamental.

- Nature of construction site

The construction sector is also distinguished by the nature of the construction site. The size and type of the site (building, roads, etc.): the extent of the site will tend to complicate access. Will the driver easily find the unloading area? Does the site have several unloading areas? The le location of the site: is it in an urban environment? In a pedestrian zone? Does the neighborhood configuration allow access to large trucks? Site installation: e.g., how many cranes are there? Further, the evolutionary nature of the site: does the access change, is lifting gear available…?

- Factors linked to persons working in the sector

During our interviews two factors were noted many times: languages and responsibilities. Languages spoken on a Belgian construction site and among suppliers can be up to 10 languages! The impact on communication is

therefore not insignificant and the platform should take this into account. Finally, who has authority to receive the goods? The issue of authority is more complex at bigger construction sites than at smaller ones.

4. Platform architecture

The research presented above revealed a common thread in our reflections and a logistics plan with 4 basic steps: Delivery Preparation, Delivery, Unloading and Evacuation (see fig. 2). These sub-issues facilitated the exchange with the players and the identification of general and specific problems and functionalities in response to the problems encountered by the sector, the modules in support of the new logistical opportunities, etc.

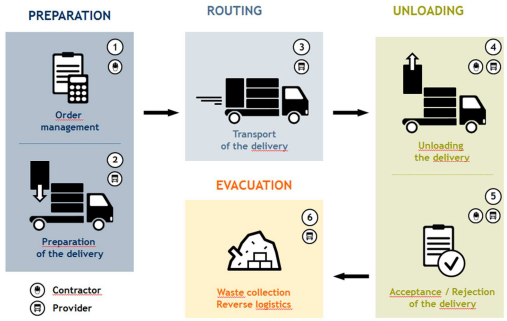

Fig. 2 Illustration of the overall logistical scheme for construction

4.1. Opportunities for URBANWISE

Among the most frequently cited feedback from our interviews, we can underline the strong interest in a "dashboard" vision for deliveries management, the need to develop a user-friendly platform available in several languages, the lack of interest in the management of parking spaces waiting before unloading or the opportunity to set up a stock exchange of materials. In the next paragraphs some more information is presented.

- Delivery Preparation

There is a sustained interest in the computerization of calls for delivery. A dashboard vision is very much appreciated. To facilitate the calls for delivery a system based on an excel table has been put forward as a convenient solution. The platform should be multi-language, at least in French, Dutch and English. Information about the construction site should be developed, with automatic notifications of updates. Other necessary elements include better tracking and validation of delivery dates and times, availability of equipment. This should go hand in hand with a better overview of subcontractor deliveries.

- Delivery

A mobile application has been validated as a real opportunity for carriers. According to the sector, there is no brake on this development in the medium term. The mobile application should be multi-language. In addition, there is a strong demand to improve the management of delivery delays. The construction sector is in great need of easier contacting drivers, transporters and site managers.

- Unloading

The platform needs to facilitate delivery control to avoid unloading errors, with centralized information. Delivery orders need to be dematerialized. The status of deliveries must be integrated and follow a logical process. Further, a crucial aspect is the reduction of problems associated with unloading equipment (or inappropriate unloading equipment (unavailability, inadequacy). Unlike what we expected, there is a low priority for the management of unloading locations or waiting zones for trucks.

- Evacuation

Evacuation is a closed market, with collectors leaving no opportunity for entrepreneurs to manage waste.
There is a high opportunity for stock exchange of materials at the end of the construction site. For some actors, there is an interest for promoting reverse logistics by the platform.

4.2. Urbanwise prototype

The architecture of the URBANWISE platform is developed in response to the needs and opportunities presented above. The platform, which consists of a database and data processing, is hosted on a server. A web interface (see fig. 3) is intended for small and medium-sized enterprises (SMEs) who do not have logistics-specific software. A system interface is intended for companies that already have their own computer system dedicated to logistics. A mobile application is intended for platform users who are mobile.

The prototype facilitates the delivery planning and improves the visibility on all deliveries to construction sites. It minimizes the use of mail, strengthens the communication between partners. Also, during delivery it improves communication and it facilitates tracking of the goods receipt.

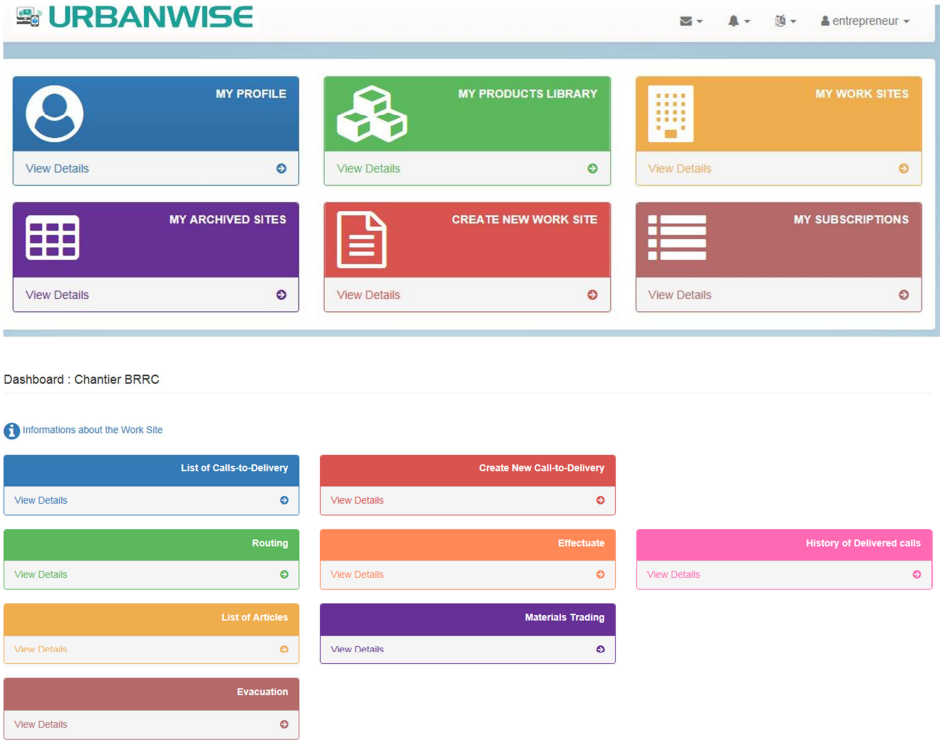

Fig. 3 URBANWISE Web interface & Dashboard for a worksite

A first feature is the management of a construction site. It is possible to virtually create a new construction site and include general information (coordinates, contact person) and specific information about delivery options (delivery hours, site plans with accessibility information, material available…). Under development are accessibility requests and a day planning.

Second, management of the construction site works with a series of functionalities.

- Construction side: it is possible to create a delivery call, and keep track of delivery proposals from transporters, choosing the transporter and confirm the adequacy of his proposal. Adjustments proposed by transporters, for example in terms of times or materials, can be accepted or refused. Further, per construction site there is a good overview of deliveries (in progress, planned today, history).
- Transporter side: overview of delivery calls (in progress, planned today, history). Mobile application to confirm delivery is functioning. The addition of several drivers has to be added in the future.

Included in the prototype is also the functionality of a product and materials library, with easy selecting and adding available. The incorporation of pre-programmed lists of materials is under preparation.

Several improvements to the existing features are in the pipeline, like an agenda view, allocation to drivers and visualization of deliveries on the mobile application. Possible additions in the longer term are notably interfaces for the automatic import of existing data without re-entry (site data, item data ...), geo-localized tracking of the delivery according to various statuses, materials exchange market.

5. Conclusion

Based on the study work so far, we can state there is a need for such a tool as Urbanwise. Nevertheless, in order to bring Urbanwise Construction to the market it is absolutely necessary to (1) focus on evaluating the platform by testing deliveries in real situations, and (2) to develop terms of use and subscription formulas. These are essential conditions to be able to valorize the actual research in practice. For a fully operational IT-platform , it is necessary to find sufficient contractors and suppliers willing to invest time. The findings of the research are typical only for Belgium. There are undoubtedly opportunities for a tool such as Urbanwise in other countries. The findings of the research go beyond the research area (Wallonia, Brussels): without major changes, a tool such as Urbanwise can be applied in other countries / language areas.

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