A SMART LOGISTICS AND TRANSPORT PLATFORM FOR RURAL BUSINESS

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ABSTRACT

There is significant potential for growth in rural economies. Despite the fact that selling products to consumers without geographical boundaries is now a reality, as a study of Scottish rural businesses shows, there is generally no straightforward strategy for how small and micro businesses may handle the logistics of distributing their products. Digital technologies are key enablers for managing logistics tasks in today's cargo business. Fourth-Party Logistics providers (4PL) utilise these technologies to manage the flow of information and goods and provide comprehensive logistics services. This paper addresses the following question: "How to adapt the idea of Fourth-Party Logistics provider (4PL) from the cargo business sector to the rural SMEs context?" Exploratory work has been conducted in order to capture rural businesses logistics needs and identify the potential areas of improvement in their logistics processes. The findings show that companies usually have long-standing and trusted relationships with small transport service providers that can provide a flexible and reliable service at low cost and tailored to their needs. In order to utilise their transport resources in an optimised way, one solution identified is that companies work together towards the formation of horizontal cooperation to offer combined services. This cooperation depends on means to share information about scheduled deliveries, so that other businesses can schedule their deliveries within the same journey. In this paper we propose the introduction of 4PL services to the rural business community that enables businesses to: (i)

offer transport capacity to others; (ii) identify and contract potential transport providers; and (iii) share provenance information and monitor service provision.

Keywords: Logistics, rural economy, transport.

INTRODUCTION

Small and Medium Enterprises (SMEs) are fundamental economic pillars of the European economy (Holter at al., 2008). In the UK, SMEs represents 99.9% of the total number of businesses in the country, provide 59.1% of all private sector jobs and generate 48.7% of total public sector turnover in the UK (Stockwood, 2011). There were an estimated 4.8 million private sector businesses in the UK at the start of 2012, from which 99.9% were SMEs. Among SMEs, micro and small businesses (0-49 employees) count for 99.2% of the number of businesses (Department for Business, Innovation and Skills, 2012a). In this context, it is expected that the recent news of a £60m small business scheme launched through the Regional Growth Fund will create or safeguard over 8,000 jobs over six years across the UK (Department for Business, Innovation and Skills, 2012b); furthermore there is potential for the UK SMEs to create more than 450,000 new jobs if more funding was available (is4profit, 2012, Hunter, 2012). Given that many SMEs are located in rural areas, the rural economy plays a fundamental role in influencing the potential of SMEs for growth and relevance for the economy. Digital technologies are often seen as a key enabler to such growth.

Although selling products to consumers without geographical boundaries is now a reality, there is generally no straightforward strategy for how small and micro businesses should handle the logistics of distributing their products (Marqui et al., 2012). Additionally, in their study focusing on SMEs logistics practices, Holter et al. (2008) showed that small businesses were generally operating as “order takers” from the transport market. In summary, order takers are companies that don’t know or are not able to benefit from the competition in the transport market. As a result, the Logistics Service Providers (LSPs) are unresponsive to demands for service improvements and rate reductions (Holter et al., 2008). Taking into consideration the unique characteristics of SMEs, such as scarcity of resources, lack of knowledge and little purchasing power, it is even more difficult for SMEs to escape from such a position of “order taker” (Holter et al., 2008). Regarding the resource constraints that are part of the SME environment, this includes scarce financial resources for investment and human resources for processes analysis and improvement (Brau et al., 2006, Holter et al., 2008, Soinio et al., 2012). The resulting lack of purchasing power is a result of low-transport volumes (Holter et al., 2008).

This paper addresses the two key questions as follows:

1. What are the logistics issues faced by rural SMEs businesses?

2. How to adapt the idea of Fourth-Party Logistics provider (4PL) from the cargo business sector to the rural SMEs context?

Even though there is no consensus about the definition of SMEs, we adopt the definition of micro business as any business employing 0-9 people, small business as one with 10-49 employees and medium business as one with 50-249 employees. Businesses employing 250 or more are considered large businesses.

In this paper, we present results from an investigation into transport needs of rural SMEs. From this investigation we derived a set of requirements for logistics services and we discuss how 4PL functionality can be introduced for rural SMEs.

LOGISTICS PROCESSES

Before exploring the issues faced by rural SMEs in their logistics processes, we provide an overview of the logistics processes and the main parameters used in order to measure when the service provided is meeting demand requirements or the expected Logistics Customer Service (LCS). According to La Londe et al. “customer service is a process for providing significant value-added benefits to the supply chain in a cost effective way” (1988, p.5).

From the definition of logistics provided by Bowersox et al. (2010), which says that “logistics is the combination of a firm’s order management, inventory, transportation, warehousing, materials handling, and packaging as integrated throughout a facility network”, and from previous research on SMEs logistics processes (Marqui et al., 2012, Holter et al., 2008) we decided to narrow down the scope of this research to transportation. The reasons for focusing on transportation within all the logistics processes are:

- The internal logistics (materials movement) within the organization in many SMEs can be simple, particularly as we are addressing mainly micro and small businesses; therefore it is not their most critical logistics process;

- As we focus on rural SMEs, there are also cases where the inbound logistics is simplified by having part of their supplies coming from their own rural activities, such as production of Jersey ice cream in farms that breed Jersey cattle;

- Finally, distribution is a key factor for the success of any business, because if your product does not reach the consumers the entire supply chain has failed. We therefore focus on transport management, which according to Bowersox et al. (2010) represents over 60% of a typical firm’s logistics expenditure.

The literature regarding logistics practices in SMEs is scarce. Besides this, there is a common understanding that transport and the other logistics services should be addressed as an integral part of the supply chain (Holter et al., 2008, Soinio et al., 2012). Even though in this research we focus on transportation, we also agree that transportation must be seen as an integral part of the whole supply chain. Therefore, the supply chain represents the boundary of the study. Within the supply chain context, we address the following parameters of a transport process:

- Transport rates: we investigate the relevance of the current transport rates to the business;
- Transit time: the elapsed time between order despatch and order delivery;
- Transport visibility: what information is available to the stakeholders during the execution of the transport task;
- On-time delivery: the punctuality of deliveries according to expected delivery date and/or delivery time
- Cost of transport management: effort required, from the sender point of view, in order to schedule a delivery, such as transport order convenience and LSP system flexibility; usually this costs are not included in the price of the service, but they can be measured in terms of time of an employee spent in this tasks.

CASE STUDIES

Due to the nature of this research an exploratory qualitative approach was adopted with interviews with rural business owners in North East Scotland being the main source of data. The exploratory approach, using a semi-structured questionnaire was motivated by the need to cover different business types, with specific product features and distribution characteristics.

The elements of Logistics Customer Service (LCS) (La Londe and Zinszer, 1976) provided the foundation for the semi-structured questionnaire. This framework was particularly relevant in the early stage of this research, before focusing on the transportation process, as the framework provides a wider view of the whole logistics processes. By taking the rural SMEs as the focal company in a supply chain, we explored the LCS that the focal company offers to their customers and what is the expected logistics service level in this link within the supply chain.

The company selection followed in two stages. First, individual companies were invited to take part in the research and agree to an interview. The second stage consisted of a snowball sampling method, in which we asked the company interviewed to indicate potential respondents to the questionnaire, based on their network. In this process, we identified that one of the respondents was developing horizontal cooperation, therefore we invited their partners in the cooperation to take part in the research as well. Unfortunately, we managed to get access to only one of their partners, who agreed to participate in the interview. In another case, there was a vertical cooperation between the companies, in which we managed to get access to both partners. All the interviews were recorded, the relevant information was transcribed and analysed. Confidentiality of participant firms was assured.

Case Description

In this paper we present the result of the interviews with four rural business owners, which we call Case A, Case B, Case C and Case D.

Case A is a small farm-based business located in a rural area, which started operations in 2006 and currently employs 3 people full-time. The main products of the company are premium fresh fruit coated with chocolate. Their annual turnover is £80,000 and they sell their products via two different channels: 50% through trade partners, and 50% through online sales directly to consumers.

Case B is a small home-based business in a rural area, which started operation in 1999 and now employs 3 people full-time and 2 part-time. Their main products are organic preserves. Case B has three distribution channels: trade partners, online sales directly to consumers, and farmers' markets. Most of the volume is sold via trade partners.

Case C is a small business located in a rural settlement, was founded in 2008 and currently employs 2 people full-time and 2 part-time with a turnover between £80,000 and £85,000 a year. Their main products are salad dressing.

Case D is a small home-based business located in a rural area, was founded in 2008 and currently employs 2 people full-time. The company makes use of outsourcing of most of their manufacturing activities. Their main product is rapeseed oil. Both Company B and Company C did not reveal their annual turn over.

Empirical Findings

Table 1 summarizes key aspects of the distribution processes of the participating companies.

In case A, the main issue is the origin of the product that establishes the boundaries to be overcome. As stated by the interviewee, the courier company currently providing the logistics services to their distribution is the only available option that makes a collection from a rural area in North East Scotland. Even though the company is satisfied with the service they receive, the fact that they are dependent on a single service provider is a weakness and potentially threatens their business. Being able to have a number of options from which they could select the one that better suits their needs is the ideal and desired market condition for long-term business sustainability.

Table 1 - Parameters of a transport process.

	Case A	Case B	Case C	Case D
LSPs	Courier – the company chose a specific courier that offers next day delivery for a package leaving from a rural area in North East Scotland	The company operates a mix of different forms of delivery. To consumers they send the order via parcels, using a third part courier. To trade partners they make the deliveries themselves, and in some cases they share (coordinate) the delivery with other SMEs nearby.	The company has a partnership with an oil producer (which also supplies the oil for their salad dressing). Most of the distribution is through the distribution system of the oil producer, so that the company does not have to manage this distribution. For orders to other areas that are not covered by the oil producer, the company uses a courier. This is mainly for customers in the Highlands and Islands. There are still occasional collaborations with other SMEs like Case B.	For orders to customer in a radius of up to 20 miles, the company deliver themselves. For distances above 20 miles, the company uses a courier service
Transport rate	A standard rate applies to all orders sent to UK mainland, which according to the company does not affect the competitiveness of the business	Due to the high density of their product, the rates to send to individual consumers is prohibitive to reach areas outside Scotland, even though the company has already identified potential customers in London, for example.	The partnership with the oil producer includes sharing some of the distribution costs, but rates are not an inhibitor to the businesses. For the courier option, there is only one local LSP that operates with cost-effective rates.	A standard rate applies to all orders sent to UK mainland, which according to the company does not affect the competitiveness of the business, but it is an extra cost to the company
Transit time	24 hours	Up to 7 days	48 hours	Next day delivery

Table 1 - Parameters of a transport process. (Continued)

Transport visibility	The LSP keep the company well informed of the progress of the parcel. The company has developed a close relationship with the courier over the years, which contributes to better information flow.	The company monitors the orders sent via courier using the tracking system supplied by the courier.	The company does not monitor dispatched orders. The oil producer, who has incorporated the dressings in his product portfolio, also manages the distribution. The sales sent via courier are usually to very small businesses in the Highlands and Islands. There is no tracking system in place.	The company uses the courier's tracking system. They have an interface in which they are able to see when the order was delivered, who signed for it and the exact time of the delivery
On-time delivery	The main product has a shelf life of one day; therefore, punctuality of delivery is critical. Failure to deliver increases the risk of losing the customer.	The long shelf life of their products, associated with the promise of 7 days delivery time, gives the company more flexibility in terms of punctuality, as this delivery window of up to 7 days already covers most of the potential problems and delays.	Products with long shelf life and the good performance of the courier have been working satisfactorily. Even if one order is delayed by one day, this is not an issue. The exception is for a catering event, when particular care is taken to make sure the customer receives the order on time.	According to the respondent, the order-to-delivery time of around 2 days is fast enough. There are different couriers that can provide this service, in this case, everything comes down to price.
Cost of transport management	The long-term relationship reduces the cost of pre-transaction negotiations and demand requirements clarification, as the LSP understands the businesses specific needs. The delivery monitoring is via the courier (LSP) tracking system.	The deliveries to trade partners are time consuming either in making the delivery itself, or in coordinating the delivery with other businesses around the area. The company has implemented a shared calendar in order to try to optimize the coordination of deliveries, but the company recognizes that improvement is still required.	As most of the volume is distributed via a business partner, who does all the transport management, this is a minor cost to the company.	The actual courier service provider is punctual regarding the delivery times; therefore, the company does not need to spend efforts between sending an order and acknowledging that the order was delivered. Usually the main management effort required is the checking at the end of the day that all deliveries have been accomplished.

In case B, the company is doing part of the delivery themselves, which indicates a lack of competitive transport provider options. As in a small business human resources are scarce, in case B it is not different. Currently employing 5 people, 2 of them part-time, the time spent making deliveries could be used in the core activities of the company. The company has put in place some initiatives in order to reduce the number of journeys and/or reduce empty space in each journey. This can be categorized as horizontal cooperation in logistics activities (Cruijssen et al., 2007). The only issue is that logistics is not the core business of the involved parties.

Case C describes a vertical collaboration between a producer of salad dressing and its oil supplier. The oil supplier (described in case D) is a farmer who grows oil seeds and sells oil products all over the UK. Company C, the salad dressing producer, is delivering to local markets and also uses its supplier of oil as a distribution channel to more distant markets. Both companies appear on the labels of the product, which is a marketing tool and increases the visibility of both brands on the market. As a result of this vertical collaboration, their transport activities are more cost-effective, as empty returns are usually avoided. Apart from this distribution channel, company C also delivers to local markets. With that, they encounter the same problem as the other rural businesses studied in this research, in that they only work with one transport service provider.

Case study D is based on an interview with company D, which is the oil producer and collaborator of company C. This company grows oil seeds, but outsources all the processing for converting their crops to oil to subcontractors. Besides selling the oil itself under their own brand, they also have products in their repertoire, such as salad dressing, infused oil etc, that are produced by subcontractors, such as company C. Having a broader range of products, they choose to sell to small independent and specialised retailers (40% of their products) and directly to restaurants and catering companies (also 40%), with a small percentage of their products (20%) being directly sold to end consumers. In terms of transport, they will deliver to customers directly up to a range of 20 miles, as this is more cost effective than using a courier service. For distances above 20 miles, the company uses the services of a courier company.

DISCUSSION

From the empirical investigation, we have identified that delivery fulfilment for rural businesses is predominantly small-scale. Transport activities in order to meet this niche market may operate under quite different requirements, compared to traditional cargo shipment.

We can identify two different profiles for logistics customer services from the study conducted. The companies interviewed either sell highly perishable, personalized and low-weight products or their products are standard (non-personalised) high-weight, low value and non-perishable. Each of these two categories of product vendors has specific transport service requirements. For perishable products, companies prioritize concerns such as quality

and on-time delivery. As the study shows, for these companies, a long-term relationship with trusted transport providers is a preferred choice.

The profile of the participating case study companies is shown in Figure 1. First, the bottom right corner of the matrix shown in Figure 1 refers to case A, which is of perishable and low-density products, giving a high-end profile in which the cost of delivery does not affect the competitiveness of the business. On the other hand, the top left corner refers to cases B, C and D. These three cases represent companies with non-perishable and high-density products.

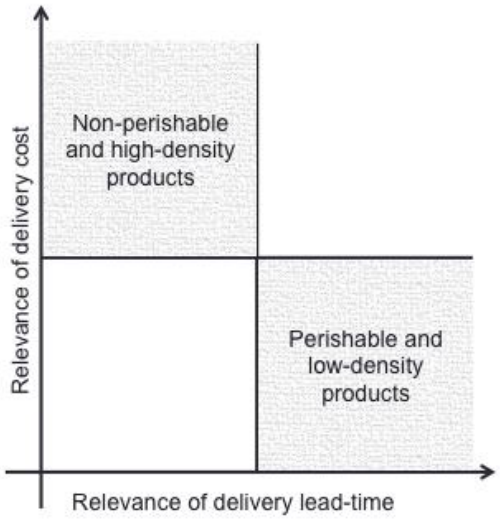

Figure 1 - Profile of participating Companies

Cases A, B and C only have one courier service provider that is able to meet their transport needs in the best possible way. In order to overcome this lack of options, the companies have developed different forms of collaboration. Case B has established a horizontal collaboration with case C. On the other hand, case C is involved in a vertical collaboration with case D. This collaboration was eased by the fact that their supplier of oil also benefits directly from the success of their business. The fact that it is a supplier that also has its own brand on the labels of the final product of the company B (dressings) means that the collaboration works like an outsourcing of the product diversification for the supplier. Even though company B is not involved in managing the distribution of the products sold via the oil producer, increased visibility would be beneficial, as the company would have more information related to the actual customers of their products. In the way it is currently working, Company D is the one holding all the distribution channel power.

Regarding the horizontal collaboration, the main issue is that logistics is not the core business of the involved parties. This has practical implications, such as:

1. Lack of logistics capabilities in order to maximise the potential of the cooperation;

2. Lack of focus on coordination of the distribution activities within the involved organisations, as most of the time, they will be focusing on their core business;

3. Lack of investment in ICT to support the coordination of such deliveries, which is part a result of scarce financial resources to invest in ICT, part a result of not being their core business.

There is a strong case for strengthening the horizontal collaboration capabilities of these companies. In fact, the companies themselves have identified the potential of such a horizontal collaboration and started to do that in a rudimentary fashion. The basic vision would be that potential customers (those who require a delivery service for their products) can easily get in contact with those service providers that can provide the service that best suits (or matches) their needs. In rural settings, it may be the case that such a small-scale service has to be tailored to the particular needs of customers. The congruence in terms of the relationship between a customer and a service provider is much tighter and goes beyond a simple purchase of the service and its contractual fulfilment by a delivery company. We see, from current practice, a much more interactive relationship, where a customer's desire is to remain informed throughout the delivery process in order to allow better control and high reactivity to uncertainties in the delivery process itself (along the lines "trust is good, control is better"). What can be recognized is that business opportunities may not be utilized due to a lack of information. It is therefore important to "inject" information into the rural economy to broaden the range and awareness of business opportunities.

New business opportunities can be created by allowing producers to deliver to a larger market and service providers to be able to offer their services to a wider business audience. This requires a certain disconnect between a customer purchasing a service and a service provider offering this service. Activities and responsibilities have to be delegated to arbitration services and facilitators that operate as a fourth party in these business settings. Delegation of responsibility in terms of contract fulfilment and facilitation, therefore, play an important role. It becomes necessary to introduce basic information services (which can be community-driven) as well as support more sophisticated 3PL/4PL provider schemes to enable horizontal cooperation in rural settings (Figure 2).

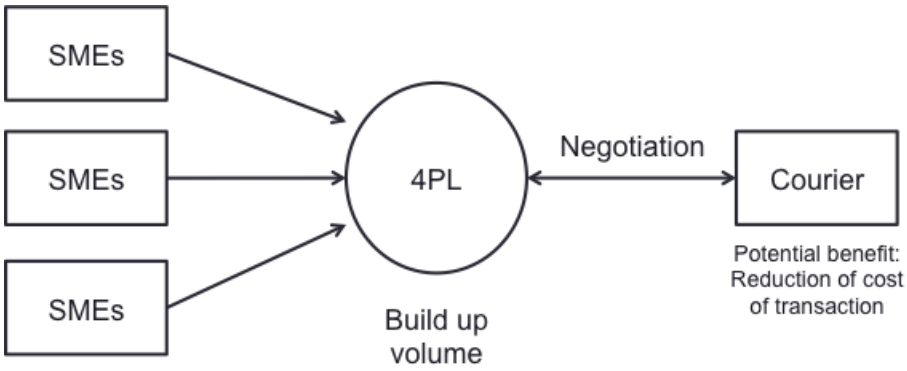

Figure 2 - The Role of a 4PL Provider

Rural businesses are generally too small-scale to organise and control the delivery of their goods beyond local markets. These companies rely on service providers that offer them a whole-sale and reliable delivery service. This points to the need to adapt the concept of 4PL service provision from the classical cargo business to the rural SME context.

A 4PL provider works as a kind of “consolidator” for transport needs of rural SMEs. As shown in Figure 2, the 4PL provider has a better bargaining power in order to negotiate with a courier service, as it can build up volume and negotiate a better price for delivery services for the SMEs, being the price of transportation part of the total cost of distribution. Moreover, transport activities of single SMEs are bundled and, therefore, transport facilities are better utilised. Such an arbitration service may lead to a reduction in transport costs for the SMEs without them being required to introduce extra IT knowhow to manage their own transport.

LOGISTICS MANAGEMENT FOR RURAL BUSINESSES

Based on our case study, we have identified particular concerns that a computational support for managing transport activities for these companies has to fulfil, such as:

- A supplier of goods needs a better overview about what transport services are available; on the other hand, transport providers need a better insight into the current demand for transport services; therefore, solutions have to be made available that allow transport providers to “advertise” the services they want to offer to potential customers, and to allow producers of goods to choose appropriate transport services from a larger number of options for transport; this requires some means to share this information and to match transport demand with transport availability;

- From the studies performed, a need for collaboration among producers to share transport resources as well as transport providers to optimise their business in collaboration with other transport providers can be detected; again, this also requires a means for sharing information among these two groups of stakeholders in transport activities, so that, for example, a group of producers can approach a transport provider as a collective and share transport costs and capacity / space;

- The stakeholders (producers, transport providers and customers) of such a transport activity are interested in having clear and up-to-date information about the ongoing execution of that activity, therefore, monitoring is essential to determine whether delivery will take place on time; the means to make monitoring information available to all the stakeholders is essential so that they can react early to deviations and problems that could arise.

The concept of electronic logistics has the potential to fulfil the basic need of information sharing and allows the provision of means for collaboration between stakeholders. This will include real-time tracking and tracing, performance evaluation of logistics providers, and security and trust concerns. In the following paragraphs we review some innovative logistics solutions that attempt to satisfy some of the requirements we mentioned above. We introduce the concept of autonomous logistics and discuss concepts such as object memories and e-contracting that have been used to implement autonomous logistics.

In general, the paradigm of autonomous logistics decentralizes control and decision-making to some logistic entities (products, packages, truck, etc.) that participate in the transport and logistics processes. It is suggested that these logistics entities (typically implemented as intelligent software agents) are able to process information, to make and execute decisions on their own, and to cooperate with each other to achieve their optimal objectives (Schuldt, 2012). In line with autonomous logistics, the ideas of object memory and e-contracting have been proposed (Windt and Hülsmann, 2007).

We distinguish two forms of facilitation and third-party service provision:

- A simple arbitration service that allows producers to find potential transport providers: producer and service provider engage in a direct contractual relationship;

- A producer engages in a contractual agreement with a logistics service provider that acts as a fourth party and arbitrator between customers and logistics service providers.

Simple arbitration is a simple form of facilitating the delivery fulfilment by a service provider. It is an information service that allows service providers to advertise their transport and delivery services, from which a customer can select the service that best fits their needs. Simple arbitration is a first step in injecting more information into the economy. For service providers, it is a mechanism to inform potential customers and advertise their product, which is a transport/delivery service, to a wider audience.

State-of-the-art software concepts and web technology may help to achieve such a simple information service. The complications are of an organizational nature. Producers have to deal with contractual issues and monitor the delivery of their goods closely, in particular with multiple service providers involved (for example, forming a chain of delivery services). Real-world situations show that the organizational effort of doing business based on passive information services is high for customers and quickly becomes infeasible. Although more information in the system allows better networking among potential customers and service providers, the relationships formed remain simple and do not allow an extension of market operations.

Additional organizational and supporting information management concepts have to be introduced to allow small rural producers to overcome their currently rather localized market presence or dependency to one single service provider. A separate business entity, along the lines of 3PL / 4PL providers in the freight industry, has to provide a combined transport and delivery service to rural customers. In order to scale their business, small rural producers interact with this “meta” service: as the sole contractual partner, it takes on responsibilities to deliver the goods to specified destinations and delegates specific transport tasks to small-scale transport providers.

This meta-service may be established in a variety of different forms:

- A single transport company extends its business to provide such a more complete service;

- Transport service providers form horizontal cooperation and offer complete services to customers.

Central to any interaction in these delivery scenarios is the concept of a contract. As a legal instrument, it regulates the interaction of business partners and has to be established for each delivery activity. With digital technology in place, a contract also becomes an important instrument as a software entity. Beside its legal impact on the interaction of business partners, it also becomes a software construct that guides a delivery planning and monitoring platform in its behaviour to allow the distinction between a correct execution of a transport activity and one that deviates from the legal agreements between the business partners.

A software support for such a combined service provision may include arbitration functionality, as well as other aspects, such as monitoring the order fulfilment and counteracting problems.

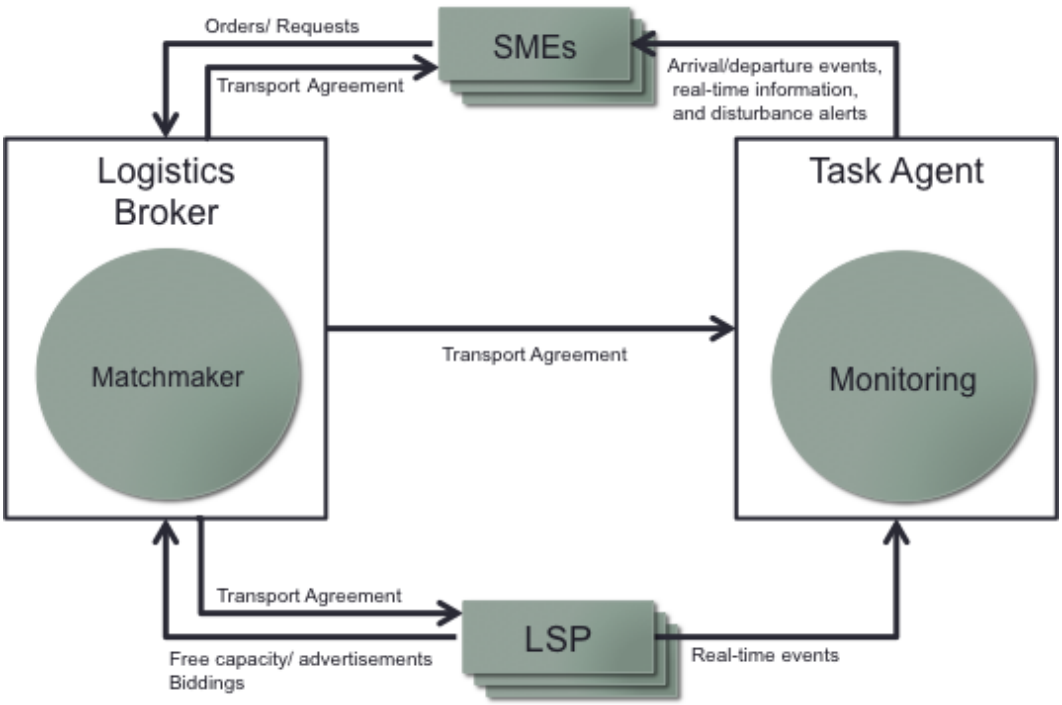

Figure 3 - Information Infrastructure for Rural Businesses

From the analysis of current practice in managing delivery by rural businesses and the discussion of basic requirements as outlined in the previous section, we can identify a need for particular features that have to be incorporated into software solutions supporting rural businesses. We propose a brokering system for logistics management tasks that supports the coordination and collaboration among businesses, as shown in Figure 3, which describes an abstract architecture of this proposed logistics broker.

The main features that have to be incorporated into this system are: (i) models of electronic market mechanisms including matchmaking and reverse auction, (ii) secure information sharing between business stakeholder, and (iii) support for shared provenance records to inform the assessment of risk and accountability in contracts involving logistics services.

Transport activities can only take place if there is knowledge available about delivery capabilities of transport service providers. One of the features of our platform is to act as a broker for finding the right services matched against customer needs. Logistics service providers that want to advertise their services via this software platform may submit their transport capacities as well as other information about their services to our logistics broker. For example, these advertisements may contain general terms of service provision, stated by the company, as well as specific terms for each of their resources (for example, they can provide services that include transport with refrigerated containers that allow to employ a certain temperature range, or prescribe maximum load capacities and dimensions).

The knowledge about available services can now be used by the logistics broker to generate customer-tailored delivery services. We envision customers of transport services (which may be small rural producers) to use the broker platform for their transport needs. Rural businesses can act as service consumers and submit their delivery requests to the logistics broker. The request contains the basic information for delivery such as the starting point, the destination, and the dimensions and weight of goods, and also some constraints including user preferences (e.g. price, CO_2 emission), latest delivery date and in-transit conditions (e.g. minimum and maximum temperatures) etc. Our broker service not only performs arbitration between potential customers and suppliers, but provides a 4PL service specifically designed for rural transport activities. This means that this transport software platform helps cooperatives of service providers to offer a one-stop service to customers in need of delivery.

When the logistics broker receives a delivery request by a customer, it queries the matchmaker for service providers that can, in principle, meet (part of) that request. It then approaches the potential service providers asking them for bids. On the basis of choices made by the consumer, the logistics broker issues a contract (in terms of a delivery plan) to the customer and selected service providers. We refer to this type of contract as a *group contract* in the sense that the group (the consumer and the service providers), as a whole, agree to fulfil the contract. In other words, the parties involved in the contract need to coordinate themselves to make sure the contract is fulfilled. Each involved partner holds the responsibility for any violation of the contract.

A delivery task is generated when the booking process for the delivery request is finalised by our platform and the resulting contracts are established. A *task agent* is instantiated by the logistics broker and is responsible for monitoring the execution of this particular task. It requires the service provider(s) to give feedback regarding the status of the on-going delivery task and make sure that its execution adheres to the agreements specified in the contract. Correct execution, therefore, has to be monitored, using technologies such as the Internet of Things (IoT) (Uckelmann et al., 2011). The IoT plays an important role in logistics as it incorporates technologies, including radio frequency identification (RFID), electronic product

code (EPC) and global positioning system (GPS) that can be used to track and interrogate 'things' being delivered. Each physical object (product, package, etc.) has an associated RFID tag which maps to an object memory which records information about the object, actions performed on it, and associated contractual obligations. In other words, the object memory provides a data structure to which different parties are able to contribute. In fact, the whole memory represents the provenance of the physical object and its delivery execution.

In a rural setting, there are small transport companies that may offer a small-scale and very flexible service (e.g. “a man with a van”). As we want to support the formation of ad-hoc teams as well as longer-term cooperatives of service providers, trust between them may determine how much they are willing to depend on each other in a team. In turn, it determines the quality of collaboration among these companies. We are developing a model to assess trustworthiness of service providers based on the analysis of provenance records about the historical performance of these providers. In other words, the trust scores of service providers are dynamically updated to reflect the quality of performance in the execution of delivery tasks, thereby giving rural businesses more informed choices when selecting the services.

As we mentioned, collaborations are often established in an ad-hoc manner which means team members usually do not know each other in advance. This raises some security concerns with respect to the sharing of business-sensitive information. Clearly, the control of information sharing between team members may be determined by the degree of individual’s trustworthiness (e.g. their trust scores described above). We are developing a risk-aware authorisation service that “traps” all attempted security-sensitive interactions, and determines whether those interactions are allowed to proceed based on the risk of information disclosure or modification. This authorisation service provides a great flexibility in the sense that some risky interactions are allowed in order to achieve the business goals.

CONCLUSION

This paper presented a field study regarding transport and delivery needs of rural businesses. This study shows that there is a market for horizontal cooperation between small transport companies to provide combined delivery services. Rural SMEs have unique characteristics such as scarcity of resources, lack of logistics capabilities and little purchasing power when facing the challenge of delivering their goods to wider markets. In order to alleviate these weaknesses, we proposed the introduction of 4PL services to the rural business community.

A 4PL service will enable the formation of horizontal cooperation among service providers for delivering tailored and reliable transport services to rural SMEs. This 4PL software platform will be based on state-of-the-art digital technology such as semantic matchmaking, electronic contracting, risk-aware authorisation and the use of provenance records to establish trusted relationships between business partners. We suggest that field tests in real-world delivery settings should be performed to evaluate the proposed platform functionalities and user acceptance.

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