Exploring the effects of information quality change in road transport operations

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ABSTRACT

Purpose: The IS literature has previously emphasized the positive contribution of IT-enabled quality information on decision making and firm performance, particularly when firms operate in highly competitive and uncertain settings. Yet, our understanding of how such information potentially transforms transport operations and generates improvements in organizational performance is limited. In response, we conduct an exploratory comparative case study of three transport firms that have introduced the Global Positioning System (“GPS”) in their operations. In this study we focus on assessing changes in transport operations due to the use of the quality information GPS provides and the link between these changes and organizational benefits.

Design/methodology/approach: Data were collected through semi-structured interviews, direct observations and archival documentation in the three transport firms. Applying methods of a comparative case study the data were analyzed by employing iterative and inductive analyses.

Findings: The results identify transport operations as the missing element in a more comprehensive explanation of previously hypothesized relationships between information quality improvements and organizational benefits in road transportation. Notably, we find that different information quality affects transport operations in various ways. In addition, improved transport operations, namely transport service planning, vehicle routing and
transport control, result in improved customer service, enhanced transport asset utilization, reduced transport costs and time, and in increased satisfaction of employees working within the transport process.

**Research limitations/implications**: A series of propositions is offered that aims to stimulate empirical research and theoretical thinking on this topical subject.

**Practical implications**: The findings offer valuable insights to transport firms, while providing and improving information quality for transport service planning, vehicle routing and transport control that results in organizational benefits linked to customer service, transport asset utilization, costs, and employee satisfaction. For information to have practical value, firms must use it in those transport operations identified as adding value to the firms’ performance.

**Originality/value**: To the best of our knowledge this is an early attempt to inform firms in the transport industry about the information quality change following from GPS use and its implications for transport operations.

**Keywords**: Road transport operations, Global Positioning System (GPS), Information quality, Process change

**Article Classification**: Case study
1. INTRODUCTION

Today different forms of uncertainty impact road transport operations (Sanchez-Rodrigues et al., 2008). Uncertainty in the form of delays, lack of coordination, delivery constraints and variable demand is a common obstacle to delivering superior customer value in this industry (Sanchez-Rodrigues et al., 2010). Practical evidence shows that transport firms lacking high quality information eventually encounter increased costs and unwanted stock holding (Sanchez-Rodrigues et al., 2008). These disturbances are forcing the transport industry to rely heavily on information and communication technology (ICT) to make its operations more efficient and effective (Cetinceviz and Bayindir, 2012).

Global Positioning System (“GPS”) technologies are one of the most widely used technologies firms adopt to manage their road transport operations. A reduction of costs and an increased speed of internal operations are some of the most emphasized benefits of GPS use (Mintsis et al., 2004). Yet, the extent of these benefits largely depends on the quality of the information provided to dispatchers (Rishel et al., 2003), such as information about the location and movement of a vehicle, the driving times of a driver, and a driver’s break periods (Mintsis et al., 2004).

ICT literature discussing GPS use in road transport has previously emphasized the positive contribution of ICT-enabled quality information on decision making and firm performance, particularly when firms operate in highly competitive and uncertain settings (Rishel et al., 2003, Theiss et al., 2005, Coronado Mondragon et al., 2009). However, our understanding of how the use of such information transforms transport operations and generates improvements in organizational performance is limited. In response, we carry out an exploratory comparative case study research of three transport firms that have introduced GPS into their operations. In this study we focus on assessing changes in transport operations due to the use
of the quality information GPS provides and the link between these changes and organizational benefits.

In what follows, we first illustrate the role of GPS in road transportation followed by the importance of information quality in transport operations. We then outline the research methodology used in the study, followed by an analysis of the data and answers to our research questions. In the discussion section we explore the implications of our findings and offer several propositions. The paper concludes with avenues for future research.

2. CONCEPTUAL FOUNDATIONS

2.1. Use of the Global Positioning System (GPS)

GPS is a satellite navigation system that allows marine, airborne and global users to determine their location (Ko et al., 2010, Finger, 2010). Due to the falling costs of GPS receivers (Gibson and McKenzie, 2007) they can today be found in a variety of land-based settings (such as emergency vehicles, police, vehicles, public transport vehicles) (Faouzi et al., 2011) and it appears to be the preferred solution for process management in transport firms (Shen et al., 2011). In transportation, GPS is mainly used in vehicle fleet management and monitoring (Mintsis et al., 2004). In combination with an appropriate Geographic Information System (‘‘GIS’’), GPS solutions offer very detailed information about the location of a vehicle or shipment at a specified time, what route is being travelled, the speed of travelling, the starting point, and the route travelled (Stopher et al., 2008).

The use of GPS brings many direct benefits for transport planning. Vehicles equipped with a GPS device rapidly provide data to the transport office which then circulates congestion information (Thill, 2000). Moreover, GPS devices allow firms to process information about a shipment instantaneously, thereby eliminating the need for the truck to return to the transport office (Theiss et al., 2005). GPS use in logistic fleet management can also effectively improve
the picture of true route-making patterns (Bricka et al., 2012), improve the driving cycle (Nesamani and Subramanian, 2011), reduce the costs of communication (Cantor and Macdonald, 2009) and increase the productivity, safety and security of the firms’ vehicles (Yuan et al., 2010).

2.2. Information quality

The existing literature suggests information quality is a vaguely defined concept (Lillrank, 2003) with no single established definition for it (Ruževičius and Gedminaitė, 2007). For the purpose of this work we adapt the definition of information quality offered by Ruževičius & Gedminaitė (2007): information characteristics and dimensions to meet or exceed the expectations, requirements or needs of the dispatchers.

It is broadly recognized that the availability of quality information plays a critical role in the success of firms (Hartono et al., 2010). Firms which have learned to react to information have a better understanding of their internal operations (Gorla et al., 2010). However, to contribute to a firm’s performance information must be good quality and support decision making in those business processes whose results add value to the firm (Davis and Golicic, 2010). Quality information in road transport operations enhances decision making (Büyüközkan et al., 2012), improves fleet resource management (See, 2007) and makes fulfillment of the customers’ changing needs and requirements easier (Gorla et al., 2010). Yet, problems with low quality information proliferate today in many knowledge-intensive processes (Eppler, 2006), including transport processes. These problems can lead to unproductive work, overloaded dispatchers and ultimately to wrong or late decisions and low quality services.

3. RESEARCH METHODOLOGY

Because the area of investigating GPS implementation and use is still in the early stages of research, we adopted an exploratory case study method. We employed a multi-case design
that supports a “replication logic” where results are more focused than overarching theories and more valid and generalizable than those of single-case studies because the findings are deeply grounded in varied, empirical evidence (Yin, 1994). Applying prescribed methods of a comparative case study (Eisenhardt, 1989), we selected theoretically relevant cases, collected case data, and conducted iterative and inductive analyses.

3.1. Research context

To study the proposed problem and achieve the exploratory objectives we introduced two case selection criteria. First, we focused on Slovenia as one of the youngest European countries that underwent challenging transition times in the early 1990s, when it faced a series of political and economic changes (Podnar, 2005). Slovenia has a 10% higher share of industrial companies and a 10% lower share of financial companies compared to the EU, with the Slovenian trade structure indicating a growing trade orientation towards the EU (Bohnec, 2003). Second, we chose the transport industry whose accessibility and affordability is increasingly important in establishing government policies (Lucas and Nicholson, 2003). We carried out the research within three fast growing and reputable transport firms in Slovenia that have already implemented and used GPS. We theoretically sampled the firms to fit our research focus. The selected companies have been able to achieve growth in workforce structure, annual revenues, and fleet size. We also searched for firms with similar relationships (e.g. history, ownership etc.) that would aid in comparisons and replication, yet with sufficient heterogeneity to help assess potential generalizability. Detailed information about the participating case study firms is presented in Table 1.

[Insert Table 1 here]

3.2. Data collection
We carried out this research using qualitative methods from multiple sources (Eisenhardt, 1989). Data were collected from three main sources (see Table 2): (1) semi-structured interviews; (2) archival documents; and (3) direct observations. Interviews were our primary source of inductive data, while archival material and observations extended our understandings of the researched theme and added value to the interview findings.

We conducted a total of 17 interviews with the firms’ employees involved in the transport process directly (dispatchers) or indirectly (administrators). The interviews were conducted over a period of 2 months from March to May 2011, and their length varied from one hour to one hour and a half (the average length was one hour and 10 minutes). We selected the interviewees based on their working position in the firm, their length of employment and their level of responsibility in the firm. Our goal was to obtain data from multiple levels and perspectives. Using theoretical sampling, new informants were chosen so as to either confirm or challenge the emerging patterns of data. Finally, we stopped collecting data when it reached a state of theoretical saturation with respect to a particular issue. All the semi-structured interviews were tape recorded and later transcribed for further analysis. They were translated into English by the first author.

Annual financial reports, GPS handbooks, transport reports, quality standard manuals, and process descriptions were the main internal documents we examined. We focused on the documentation used when conducting the transport process before and after implementing and using GPS. Handbooks with a description of GPS, including the device installed in the vehicles and the GPS software installed in the transport office, and the instructions for GPS operation and handling were also consulted.
From March to June 2011 we recorded how the dispatchers use GPS when organizing the transport, how GPS is used by the driver of a vehicle, and how the available information in the GPS software is used by other departments for further business activities.

3.3. Data analysis

Our data analysis was iterative and followed the four-stage approach proposed by Miles and Huberman (1994).

After we had conducted all the interviews we first examined all transcripts separately within each case. We identified patterns and variance in descriptions of the information quality change. For classification purposes we used Eppler’s (2006) information quality framework. To assess the reliability of the generated open codes we then involved a second coder with considerable qualitative research experience. All differences of opinion were resolved verbally between the authors and the independent coder.

In the second stage we looked for patterns within each case. During this stage we examined all conclusions derived from the coding and established links among the previously stated categories. We allowed concepts and patterns to emerge based on the primary data we had collected, while new categories were added and others were regrouped when further interviews were analyzed. The analysis continued until new analysis was not providing any additional insights.

To enhance generalizability as well as to deepen our understanding and explanation, in our third stage we focused on comparing the data collected for each category across the cases. The main intention was to compare and contrast the reasons behind the GPS use, the information quality change and implications for the firm. To access the reliability of each dimension we first involved the second coder where all disagreements were resolved through discussion and debate. Secondly, we shared the results of the initial analysis with key
informants at the three firms and an independent professional in the field to assess whether the conclusions we had reached were plausible.

In the last stage, our data analysis moved back and forth between the emerging themes and ideas and existing literatures to explore broadly possible explanations of the findings and focus on the explanation that best fit the data.

4. FINDINGS

The data analysis revealed that not all of the information quality criteria adopted in our study were subject to change after the introduction of GPS. The most evident changes in information quality relate to transport planning, vehicle routing and transport control (as depicted in Table 3). To present our results, we firstly elaborately explicate the information quality change in transport planning as seen through enhanced accessibility and convenience. We then examine the changes in information quality for vehicle routing. Interestingly, applicability and timeliness were reported to be the prevailing dimensions for each firm. Lastly, across the cases the informants reported accuracy, currency and correctness as information quality criteria of primary concern when controlling the transport process.

[Insert Table 3 here]

4.1. Transport planning

The transport planning operations depicted in our case studies experienced a drastic transformation after the introduction of GPS. When planning transport several limitations need to be considered by the dispatchers, such as the predicted delivery time, the location of previous transports, the working and driving hours of the driver, and vehicle maintenance requirements. Across the firms the interviewees shared similar views that the accessibility of information plays a crucial role in transport planning. One informant explained:
“If we have more than one vehicle available for a specific transport it is essential to know when the vehicles will unload the goods from the transport previously conducted. Thus, the dispatcher monitors the position of the vehicle and number of hours already made as well as driven. GPS provides access to the required information, obtained either automatically or manually from the transport office” (Quality Assurance Manager, Firm A).

Another elaborated:

“Before we start planning the transport we always check in the GPS system whether the vehicle needs to undergo specific maintenance work. The maintenance manager enters the requirements and time plans of all maintenance work into a separate information system which is integrated with the GPS system. If regular repairs or other maintenance are required, we approve the availability of the vehicle in the GPS system, which then sends a confirmatory message to the maintenance shop” (Dispatcher, Firm C).

In addition, repeated transports ordered from the same customer are expected to be performed in the same way as similar previous transports. This includes adhering to standard procedures of informing the customer about delivery times, loading and unloading places for vehicles, distances covered, and the number of driving hours and overall hours spent on these transports. These procedures are in most cases designated after completion of the first transport. Across all the cases the firms reported that dispatchers need to cooperate in shaping these transport procedures. This was especially evident in Firm B:

“When the customer ordered the transport on the standard route, the dispatcher examined the detailed report of previously made transports. He accessed this report in the GPS system. This report included the route the driver took, the length of the transport (measured in hours), and the dynamics of informing the driver and the customer about the transport details” (Observation notes, Firm B).

The increasing dynamic of the transports, particularly on shorter distances, forces dispatchers to shorten the execution of the transport (Roh et al., 2009). The time allocated to transport
planning is diminishing compared to other activities, such as vehicle routing, and dispatchers thus seek high quality information to reduce the risk of making mistakes in this early phase of transport operations. GPS enables the users to determine some of the parameters of viewing the transport information in a convenient way. A dispatcher from Firm A, focusing its operations on countries adjacent to Slovenia, explained:

“When the customer calls us for an urgent collection of goods, I firstly check if any of our vehicles are close to the collection place. The positions of all vehicles in the GPS solution are grouped together according to the distance from the target location, but the view can also be conveniently adapted to case-by-case needs. I can easily decide whether we have the possibility to collect the goods and which vehicle is the most appropriate for collecting them” (Dispatcher, Firm A).

Moreover, manufacturing firms – the customers of transport services – are progressively introducing the just-in-time principle to prevent congestion and unproductive inventories (Low and Show, 2008). Firms are thus increasingly using booking systems to plan the arrival time of a vehicle at manufacturers’ warehouses. When making a booking for the collection of goods, the booking system requires a determination of the time of the vehicle’s arrival, the vehicle details, the name of the driver, and the number of the transport order given by the customer. A variety of such information is available to the dispatcher through the GPS solution by using custom filtering criteria. Yet, not all transport relevant information is readily available to the dispatchers, making the planning somewhat challenging. In Firm B, for instance, they emphasize:

“The GPS solution enables us to filter the information in accordance with predefined criteria, such as the license plate number, date, and name of the driver. Nonetheless, the distance from the target position and working hours already driven are the two most important filtering criteria in transport planning. Unfortunately, they are not included in the GPS solution as standard criteria nor can they be customized to fit our needs” (Dispatcher, Firm B).
4.2. Vehicle routing

The distribution of goods with a limited number of vehicles to a predetermined set of customers with their specific demands represents the principal set of challenges in vehicle routing (Gayialis and Tatsiopoulos, 2004). These challenges are being solved daily by dispatchers who strive to increase the effectiveness of fleet utilization (See, 2007). Across the cases, the informants articulated that the GPS solution offers improvements in the practical use of information which can be used immediately and does not have to be converted, transformed or repackaged before being harnessed for a particular situation. Two situations were identified in our study. First, customers constantly need to have the latest information about the position of a vehicle. In the case of urgent loads the dispatcher provides the customer with details about whether there is a vehicle close to the loading place. According to Firm A:

“The goods that urgently need to be transported to the recipient are in most cases ordered and dispatched on the same day. The rush on the customer’s side requires us to react and pass on information about the availability of vehicles rapidly. In this case, the requested information is sent directly to the customer via the GPS solution” (Dispatcher, Firm A).

Second, drivers are likely to become involved in traffic congestion, road accidents and other road inconveniences. Drivers are required to report any such inconvenience to the transport office, which then notifies all other drivers near the target position. As one logistic manager clarified:

“When a driver comes across traffic congestion he immediately sends the number of the road and road junction to the transport office. The dispatcher marks the problematic road in the GPS solution which promptly sends the message to all drivers who are within a 100-kilometer radius of this road condition” (Logistics Manager, Firm B).
Timely information – information processed and delivered rapidly without delay (Eppler, 2006) – was recognized across the cases as being decisive for customer satisfaction, cost effectiveness and the flawless performance of the transport process. The collecting and delivery location and time, weight of the goods, and potential customs clearances (if the transport is made in a non-EU country) are key transport parameters that customers frequently alter. If this happens, dispatchers – consistent with the last available position of the vehicle indicated by the GPS software – change the planned route beforehand. In addition, the transport firms strive to perform the transport service at the lowest possible cost. As toll costs average out at around 35% of all direct transport costs, drivers are instructed to take a toll-free road. Yet, drivers do not always adhere to these instructions. Dispatchers are continuously monitoring vehicle routes in the GPS software where information delivered on time about vehicle positions enables them to change the current route. Lastly, drivers are authorized to autonomously plan the route to the place of delivery. However, drivers might choose the wrong route, especially the less experienced ones. One dispatcher explained:

“When we send the instructions about the loading or unloading location we give details about the street number and name of the place with the postcode. Nonetheless, less experienced drivers might overlook the postcode which consequently results in taking the incorrect route to a place with the correct name but wrong postcode. Since we have information about the vehicle’s position rapidly delivered by the GPS solution we can easily reroute the driver to the right address” (Dispatcher, Firm C).

4.3. Transport control

The information obtained when performing transport control is later used in other transport operations such as transport planning, vehicle routing, confirming orders, customer complaint handling etc. The variety of these tasks requires good quality input information which is gathered with the help of GPS. Across the firms, the respondents agreed that the precision of
the available information is the most important aspect of transport service control. In the larger firms (Firms A and C) the information obtained by GPS is reported with higher levels of detail. A logistics manager explained:

“We routinely control the position of a vehicle, which is automatically sent to the GPS software at least twice a day. The report consists of the name and surname of the driver, the vehicle license plate, date and hour of the position, and position including: country, city, street, and street number” (Logistics Manager, Firm A).

Another added:

“Our standard periodical control of the transport service includes recording the time needed for this transport. In the GPS software we have the information about the number of hours and minutes of the driving, resting, waiting at the loading or unloading place and waiting for customs clearance” (Dispatcher, Firm C).

Likewise, GPS mostly operates automatically, without users’ interference. Information obtained independently by GPS is thus free of distortions and errors. Each of the three cases reported that information can only be gathered mistakenly if the user enters incorrect information into the GPS. For instance, a vehicle which is driving abroad is manually labeled in the GPS software with the license plate of the vehicle which is still in the home country. As the license plate is entered manually the dispatcher has contradictory information regarding this transport. Although this situation is possible, firms reported that their employees seldom make such mistakes:

“In the past we have not experienced that information gathered either automatically or entered manually would be incorrect in the GPS software” (General Manager, Firm B).

Last but not least, GPS also provides up-to-date information. The system records the position of a vehicle at specific times of the day (Firm A) or independently of the driver’s presence
(Firm B). In some cases, the user can even customize the tracking period according to individual needs:

“The system constantly records the standard parameters, such as a vehicle’s position, working and driving hours etc. The user can, however, change the tracking period based on specific needs (e.g. twice per day, every hour, at 10am and 5pm, constantly) (How to use GPS software? – Handbook, Firm A).

Conversely, while the transport firms pay separately for transport information per request made, the tracking period may be minimized. The tracking period may also be more frequent during working hours and thus the information in the time before and after work is not tracked constantly. For illustration, Firm C reported that after the working hours the tracking period is prolonged from five minutes to two hours. If the dispatcher is still at work and up-to-date information about the transport is required, he can refresh it manually.

4.4. Linking transport operation changes to a firm’s benefit

Our second research goal was to investigate the benefits arising from the change in transport operations. The data indicated that use of information in transport operations has a significant impact on customer service. As illustrated in Table 2, GPS enables a transport firm to obtain up-to-date and current information about the status of the transport, which is later shared with the customer. The quality assurance manager of Firm A elaborated: “We immediately inform the customer if there are disturbances on the road. The customer then instructs us about the following actions”. The customer’s waiting time for the updated information is therefore shortened (Theiss et al., 2005) which enables the transport firm to respond quicker to changes in the customer’s needs (See, 2007).

Moreover, the accurate and up-to-date information GPS provides gradually assists in attaining a high level of the utilization of transport assets, such as vehicles, maintenance personnel and
dispatchers. This is especially important when the customer orders an ad-hoc transport. The dispatcher immediately sends the vehicle to the loading place, which is very beneficial for the transport firm. A dispatcher from Firm B agreed: “Our yearly productivity of the fleet including 39 vehicles rose by 4 percent after the implementation of GPS”; with a dispatcher from Firm C adding: “Real-time monitoring enables the dispatcher to reduce the number and time of phone conversations with the driver, thus we can all do more within the same time”.

Likewise, the availability of high quality information allows drivers on the road as well as employees in the transport department to make their decisions with greater certainty. GPS provides the same information accuracy with less requirements for time and labor intensiveness (Jiang et al., 2005). The high level of filtering criteria in the GPS software and high trust in error-free information also helps employees in the transport department, such as a dispatcher, to perform their work quicker and with less stress: “Our employees in the transport department are evidently less distressed and work in a less hectic environment” (General Manager, Firm A). Similarly, the current information about a driver’s operation prevents the dispatcher from disturbing their daily routine. When drivers are having a break or even sleeping, they are ordinarily not contacted by the dispatchers.

Last of all, the transport firms rely on efficient routes to lower their transport costs so having information about the time, current and accurate traffic conditions is vital (Theiss et al., 2005). For example, a dispatcher decreases toll costs when re-routing a vehicle from a toll road to a toll-free road. Moreover, fuel costs and mileage savings are achieved when a driver is redirected to the shortest possible route. Similarly, the high practical use of the information delivered about traffic jams facilitates time savings since a driver is redirected less congested roads.

5. IMPLICATIONS FOR MANAGING TRANSPORT OPERATIONS
To move beyond the case findings, we reviewed other research studies for similar concepts, relationships or models (See, 2007, Rishel et al., 2003, Thill, 2000, Theiss et al., 2005). This suggested that our areas of interest had not been previously adequately researched. Our findings provide some interesting understandings of the changes to transport operations following the use of GPS and the link to a firm’s benefits.

To begin with, the information GPS provides is primarily used in transport operations when planning a transport service. Coronado Mondragon et al. (2009) suggest that information generated online referring to order status, product schedules and sales records facilitates the integrating of major supply chain processes and planning production and logistics services. In our cases, information like the position of the vehicles, traffic bulletins, the level of completion of a planned journey as well as the use and analysis of historical data is available in the specific GPS application installed in the dispatch centers. The application is then integrated with other information systems which dispatch the information to other departments, thereby helping a dispatcher to plan and execute the transport service in the most effective way (Giannopoulos, 2004). We therefore propose:

Proposition 1: The use of GPS information in transportation facilitates changes in transport planning.

In addition, GPS use facilitates changes in vehicle routing which seem to endorse benefits accruing to the firm. GPS generates real-time information about the transport service which is used for resolving real-time vehicle rerouting problems (Li et al., 2009) and enables the generation of vehicle routing plans (Repoussis et al., 2009) and generates transport information that assures efficient real-time logistics (Novoa and Storer, 2009). Our study reveals that a transport firm needs real-time information about a transport service especially when a customer orders an ad-hoc transport. The dispatcher then immediately sends the
vehicle to the loading place and selects the shortest and least expensive route. We offer the following propositions:

*Proposition 2: The use of GPS information in transportation facilitates changes in vehicle routing.*

Likewise, the use of information GPS provides is replacing traditional methods involving paper, phone and fax (Giannopoulos, 2004). The constant availability of information GPS offers enables a dispatcher in the transport office to perform the online monitoring of a vehicle. Supporting this evidence, our study revealed that modern transport firms require real-time monitoring enabling interaction with fleet vehicles. This enables a firm to control the transport service at all times, rather than only when the information is passed to the dispatcher by the driver.

*Proposition 3: The use of GPS information in transportation facilitates changes in transport control.*

Lastly, the changes in the transport operations are closely linked to a firm’s benefits. First, GPS enables transport firms to obtain up-to-date and current information about the status of a transport which is later shared with the customer. This shortens the waiting time for the customer. Second, GPS gradually helps attain the high utilization of transport assets, such as vehicles, maintenance personnel and dispatchers. A vehicle is immediately sent to the required destination where the dispatcher is able to select the shortest and least expensive route. Moreover, dispatchers are increasing the productivity by reducing the time spent on the phone with the driver (Rishel et al., 2003). Third, GPS information facilitates the greater satisfaction of the dispatchers and drivers with their working environment. Dispatchers are able to perform their work quicker and with less stress, whereas drivers are not disturbed while driving, taking a break or even sleeping. Finally, the use of GPS information enables
cost and time savings by enabling the immediate re-routing of a vehicle to toll-free or less expensive roads, or the avoiding of traffic jams. Our last proposition is therefore:

Proposition 4: The use of information in transport operations facilitates improvements in customer service, asset utilization, job satisfaction, and time and costs savings.

In addition, our findings offer some important strategic insights for transport firms’ managers. Firstly, based on the information available from GPS and the identified transport operation needs managers can make more detailed plans for their human and vehicle resources while simultaneously considering the customer’s needs. Secondly, while such decisions were previously largely based on intuition, managers now have a tool to make more sound and relevant fact-based decisions. Thirdly, such information assists managers greatly in their two most challenging tasks, namely setting the pricing policies for their transport services and expanding to new markets.

6. CONCLUSION, IMPLICATIONS AND FUTURE WORK

The existing literature provides an insight into knowledge about information quality in different industries, yet this body of literature does little to inform firms in the transport industry about the change in information quality after introducing GPS. This is particularly important since the competitive advantage of these firms is largely to be found in the extent to and ways in which such information is used. Our work responds to this deficiency, seeking to extend understandings of the changes in transport operations arising from the use of the quality information provided by GPS.

While previous literature has emphasized the need to research the benefits of introducing GPS, the role of transport operations in achieving these benefits has not yet been clearly established. For example, the European Commission’s Joint Research Center (2005) conducted a study of the potential benefits of GPS implementation in road transport, such as
the effects of GPS applications on road transport costs, transport policies and risks. However, the study did not provide any information about how these benefits are achieved. Similarly, customer satisfaction research carried out by FleetMatics (2010), a leading global provider of fleet management solutions for small and medium-sized businesses, reported on its customers’ identified benefits due to the newly available transport information derived from implementing a GPS fleet tracking system, but no detailed information was reported about changes in FleetMatics’ customers’ transport operations leading to these benefits. Another case study research by Michaelides et al. (2010) identified the benefits of using information from GPS vehicle tracking technologies within the context of the transport container industry and emphasized the need to investigate beyond the mere benefits for firms towards areas of actual improvements in transport activities leading to these benefits. While the authors suggest possible enhancements in transport activities (e.g. physical paths of vehicles, monitoring, and planning for agility), they emphasize this should be studied in more detail and beyond the single case study they had undertaken, which they noted as their main research limitation.

To address the presented gap in transport operations theory and information use theory we contribute by offering a conceptual framework (see Figure 1) that sheds more light on the influence of information quality on transport operations. While existing research mainly deals with the direct influence of GPS-enabled information for transport firms’ benefits, we introduce transport operations as the missing element in a more comprehensive explanation of previously hypothesized relationships between information quality improvements and organizational benefits in road transportation. Notably, we find that different information quality criteria (i.e. information accessibility, convenience, applicability, timeliness, accuracy, currency and correctness) affect transport operations activities (i.e. transport service planning, vehicle routing and transport control) in various ways. However, there are different
mechanisms for increasing information content quality and information access quality (Popović et al., 2009), which therefore call to be researched separately.

In addition, our findings offer some important strategic insights for managers of transport firms. Firstly, based on information available from GPS and identified transport operation needs managers are able to make more detailed plans for their human and vehicle resources while simultaneously considering their customers’ increasingly dynamic needs. Secondly, while such decisions were previously mostly based on intuition managers now have a tool to make more sound and relevant fact-based decisions. Thirdly, such information assists managers greatly in their two most challenging tasks, namely setting the pricing policies for transport services and expanding to new markets.

Yet, a series of possible challenges and limitations needs to be considered. First, our case study suffers the usual limitations of case study research. Although three case studies were conducted, this may not be sufficient to allow the generalization of the findings. While special attention was paid to ensure rigor and validity, further cases are needed to validate and generalize our findings. Next, the firms under investigation were all relatively well organized after having been in the industry for over 20 years. The effects of a change in information quality in road transport operations might differ in more recently established firms that have less structured processes. Further, seeking to learn from firms that have introduced a GPS system, we studied its influence in three small and medium transport firms. In larger firms different kinds of effects would emerge also due to the larger number of stakeholders involved. It should also be noted that the effects were only analyzed after a relatively short time; stronger and different effects might only arise over time.

We trust that our propositions will inspire empirical studies and move this field of research forward. However, whether and how our propositions apply to other contexts raises important
questions. For researchers, there are exciting new areas for further investigation. We encourage future studies to extend our work to larger firms. Next, while the growing importance of information sharing has been proposed in supply chain contexts (Li and Lin, 2006), exploring possible uses of GPS as an enabler of information sharing calls for more targeted, empirical research. In addition, another direction for future studies lies in clarifying the initial employee resistance arising during the GPS implementation phase. Employee resistance might substantially inhibit the positive organizational effects following GPS use. We hope that this study will spark future attempts to elaborate our findings.

7. REFERENCES


Figure 1: Information quality and transport operations change model
### Table 1: Overview of the case firms

<table>
<thead>
<tr>
<th>Firm</th>
<th>Year founded</th>
<th>Services and specialization</th>
<th>Number of employees</th>
<th>Annual revenue in €</th>
<th>Number of vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm A</td>
<td>1978</td>
<td>Land transport in the EU using road trains and mega trailers, maintenance</td>
<td>61</td>
<td>€5,718,735</td>
<td>45</td>
</tr>
<tr>
<td>Firm B</td>
<td>1986</td>
<td>Land transport of frozen food</td>
<td>54</td>
<td>€2,745,945</td>
<td>39</td>
</tr>
<tr>
<td>Firm C</td>
<td>1990</td>
<td>Land transport in the EU using road trains and mega trailers, maintenance</td>
<td>117</td>
<td>€15,960,277</td>
<td>69</td>
</tr>
</tbody>
</table>

*a) All information as at end-2010

### Table 2: Data sources

<table>
<thead>
<tr>
<th>Firm</th>
<th>Source 1 – Semi-structured interviews</th>
<th>Source 2 – Firms’ archival materials</th>
<th>Source 3 – Office and field observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm A</td>
<td>General manager</td>
<td>Annual financial reports</td>
<td>Office observation – 1 month</td>
</tr>
<tr>
<td></td>
<td>Quality assurance manager</td>
<td>Customer satisfaction surveys</td>
<td>Full explanation of system functions</td>
</tr>
<tr>
<td></td>
<td>Logistics manager</td>
<td>Annual management review reports</td>
<td>Participation in actual organization</td>
</tr>
<tr>
<td></td>
<td>Dispatcher (3)</td>
<td>GPS booklets</td>
<td>of the transport</td>
</tr>
<tr>
<td></td>
<td>Administrator</td>
<td>Transport reports</td>
<td>Study of the system in the vehicle</td>
</tr>
<tr>
<td></td>
<td>Total: 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm B</td>
<td>General manager</td>
<td>Quality manual</td>
<td>Office observation – 3 weeks</td>
</tr>
<tr>
<td></td>
<td>Logistics manager</td>
<td>GPS instructions and booklets</td>
<td>Full explanation of system functions</td>
</tr>
<tr>
<td></td>
<td>Dispatcher (2)</td>
<td>Process instructions</td>
<td>Study of the system in the vehicle</td>
</tr>
<tr>
<td></td>
<td>Total: 4</td>
<td>Transport reports</td>
<td></td>
</tr>
<tr>
<td>Firm C</td>
<td>General manager</td>
<td>Annual financial reports</td>
<td>Office observation – 3 weeks</td>
</tr>
<tr>
<td></td>
<td>Transport manager</td>
<td>Annual management review reports</td>
<td>Full explanation of system functions</td>
</tr>
<tr>
<td></td>
<td>Dispatcher (4)</td>
<td>Quality manual</td>
<td>Study of the system in the vehicle</td>
</tr>
<tr>
<td></td>
<td>Total: 6</td>
<td>Process instructions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GPS booklets</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transport reports</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Cross-case comparisons: The change in information quality in transport operations after introducing GPS

<table>
<thead>
<tr>
<th>Transport operation</th>
<th>Firm A</th>
<th>Firm B</th>
<th>Firm C</th>
<th>IQ criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport planning</td>
<td><strong>MODERATE</strong> “If the GPS in the vehicle misses the signal the transportation engineer receives a message for manual actualization of the backup sensor which receives and sends the information to the transport office. This is extremely important when the transportation engineer plans**</td>
<td><strong>MODERATE</strong> When planning repeated transports, the transportation engineer needs to look in the GPS software for historical information on previous transports. The information is archived in the GPS software for six months.</td>
<td><strong>STRONG</strong> “When we need to do regular maintenance work on the vehicle this needs to be incorporated into further transport planning. The transportation engineer accesses the information about the predicted arrival time at the workshop which is automatically sent to the**</td>
<td>Accessibility</td>
</tr>
<tr>
<td>Observation Notes: Organizing the transport</td>
<td>Observation Notes: GPS software</td>
<td>Workshop manager.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality Assurance Manager</strong></td>
<td><strong>General Manager</strong></td>
<td><strong>Transportation Engineer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MODERATE</strong></td>
<td><strong>WEAK</strong></td>
<td><strong>STRONG</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“If I want to see all the vehicles that are close to the place we need to collect goods, I just simply click on the map in the GPS software and the system shows me the vehicles that are within a distance of 50 or 100 kilometers from the required place.”</td>
<td>“The GPS software enables us to filter the information according to the predefined criteria such as: license plate number, date and name of the driver. No further customization is possible.”</td>
<td>“When I do the booking for the next transport I need information such as: position of the vehicle, working hours of the driver, and mileage covered. All the information is grouped together and seen under the license plate of the vehicle.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation Engineer</td>
<td>Transportation Engineer</td>
<td>Transportation Engineer</td>
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</tr>
<tr>
<td>The Transportation Engineer is able to filter the information also according to the status of work, for instance: empty or full, driving or non-driving and type of the vehicle, road train or mega trailer.</td>
<td></td>
<td>The filtering criteria can be changed according to the users’ requirements. The procedure is explained clearly in the handbook.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle routing</strong></td>
<td><strong>Application</strong></td>
<td><strong>Convenience</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STRONG</strong></td>
<td><strong>STRONG</strong></td>
<td><strong>WEAK</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“When a customer calls us to ask if we can load the goods that need to be delivered immediately, we firstly check the positions of all vehicles as to whether we have a vehicle close to the loading place. This information is directly transferred to the customer who decides if the proposed vehicle needs to collect the goods.”</td>
<td>“According to the contract with the biggest customer, every day we need to report to the customer the position of the vehicle transporting its goods. The GPS software automatically sends the required information to the customer who uses it in a given context.”</td>
<td>“If I want to see all the vehicles that are close to the place we need to collect goods, I just simply click on the map in the GPS software and the system shows me the vehicles that are within a distance of 50 or 100 kilometers from the required place.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation Engineer</td>
<td>Logistics Manager</td>
<td>Logistics Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The drivers need to inform us via GPS software if they come across a traffic jam on the road. According to this information, the transportation engineer can reroute other drivers to a road where traffic is reported to not be that heavy.”</td>
<td>“It sometimes happens that a driver takes a road to the wrong address. Due to the latest information about the position of the vehicle, the transportation engineer can reroute the vehicle to the right address.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transportation Manager</strong></td>
<td><strong>Transportation Engineer</strong></td>
<td><strong>Transportation Engineer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“When a customer requires a change in the planned route (e.g. a new loading place), the”</td>
<td>“In Austria and Germany the toll costs are extremely high. When the transportation engineer sees that a driver has taken a toll road instead of a toll-free highway he/she informs the driver via GPS software to change the route.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Manager</td>
<td>Logistics Manager</td>
<td>Logistics Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If a driver takes a route which is not correct or optimal, the transportation engineer is required to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Archival material:** ISO Quality Manual, paragraph 8.2
<table>
<thead>
<tr>
<th>Observation Notes: Organizing the transport</th>
<th>Archival material: ISO Quality Manual, paragraph 5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>transportation engineer refreshes the position of the vehicle. Based on this information the decision on the new route is made.</td>
<td>inform him and change the route.</td>
</tr>
<tr>
<td>STRONG</td>
<td>MODERATE</td>
</tr>
</tbody>
</table>
| If the transport goes as planned we check the position of the vehicle twice per day. The position is updated by GPS including the street name and number." | "While the map installed in the GPS is not the best one, we get detailed information about the position of the vehicle within two kilometers."
| Logistics Manager | Transportation Engineer |
| MODERATE | STRONG |
| If the transportation engineer cannot get information about the position of the vehicle from the GPS software, the control must be done via cell phone. | "During execution of the transport we have to control the working hours of the driver. We have information on how many hours and even minutes the driver has driven, waited at the loading or unloading place, taken a break etc."
| Archival material: ISO quality manual, paragraph 7.5 | Transportation Engineer |
| STRONG | STRONG |
| The information about the position of the vehicle, working and driving hours, roads etc. is updated automatically and regularly by GPS, even if the driver is not in the vehicle." | "During execution of the transport we have to control the working hours of the driver. We have information on how many hours and even minutes the driver has driven, waited at the loading or unloading place, taken a break etc."
| Transportation Engineer | Transportation Engineer |
| STRONG | MODERATE |
| The system constantly records the standard parameters such as the position of the vehicle, working and driving hours etc. The user can, however, change the tracking period based on his needs (e.g. twice a day, every hour, at 10am and 5pm). | "After 5pm when the working hours in the transport office end the position of the vehicles is updated every two hours. Therefore, for updated information the transportation engineer needs to refresh this information manually."
| How to use GPS software? - Handbook | Logistics Manager |
| STRONG | STRONG |
| The software application is installed on the server to which local users do not have access. While independently operating the system, no wrong information exists unless it is manually entered into the application (e.g. the license plate number). | "We can only control the wrong vehicle if we enter mistaken information about the name of the driver or the license plate number. The information obtained by the GPS is always free of distortion."
| General Manager | General Manager |
| STRONG | MODERATE |
| "It has so far never happened that the information in the GPS would be wrong either obtained automatically or entered manually."
| How to use GPS software? - Handbook | |
| STRONG | MODERATE |
| "We always have up-to-date information about whether the driver is driving or not. This helps us a lot so we do not disturb the driver when he is sleeping or taking a break."
| How to use GPS software? - Handbook | |
| STRONG | MODERATE |
| During execution of the transport we have to control the working hours of the driver. We have information on how many hours and even minutes the driver has driven, waited at the loading or unloading place, taken a break etc."
| How to use GPS software? - Handbook | |
| STRONG | MODERATE |
| If the transportation engineer cannot get information about the position of the vehicle from the GPS software, the control must be done via cell phone. | "During execution of the transport we have to control the working hours of the driver. We have information on how many hours and even minutes the driver has driven, waited at the loading or unloading place, taken a break etc."
| Archival material: ISO quality manual, paragraph 7.5 | Transportation Engineer |
| STRONG | MODERATE |
| The instructions on how to determine tracking periods according to users’ requirements are presented in this handbook. | "After 5pm when the working hours in the transport office end the position of the vehicles is updated every two hours. Therefore, for updated information the transportation engineer needs to refresh this information manually."
| How to use GPS software? - Handbook | Logistics Manager |
| STRONG | STRONG |
| The software application is installed on the server to which local users do not have access. While independently operating the system, no wrong information exists unless it is manually entered into the application (e.g. the license plate number). | "We can only control the wrong vehicle if we enter mistaken information about the name of the driver or the license plate number. The information obtained by the GPS is always free of distortion."
| General Manager | General Manager |
| MODERATE | MODERATE |
| "We always have up-to-date information about whether the driver is driving or not. This helps us a lot so we do not disturb the driver when he is sleeping or taking a break."
| How to use GPS software? - Handbook | |
| STRONG | MODERATE |
| During execution of the transport we have to control the working hours of the driver. We have information on how many hours and even minutes the driver has driven, waited at the loading or unloading place, taken a break etc."
| How to use GPS software? - Handbook | |