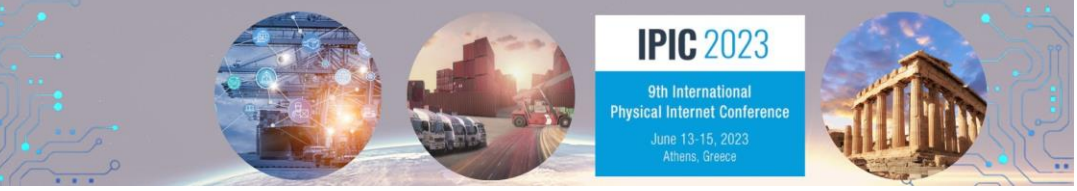

Why Fair Benefit Sharing is Crucial for a Successful Implementation of Cooperation and How it Could Work.

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Abstract: *Within this paper, we discuss benefit sharing in modern freight logistics. We propose to introduce transport management platforms for organising intermodal transports. As this idea is not new at all, we focus on the sharing of (costs and) benefits within these platforms as in our understanding one main obstacle in collaborative logistics is the willingness of people (decision makers) to collaborate with (potential) competitors. Although in a future world where collaborative logistics are well-established there might be no need for such strategies, we think that during transition a fair sharing among participants which does not advantage one of them is crucial. A simple, yet fair calculation method is presented. Impacts and future works are then discussed.*

Keywords: *fair benefit sharing, horizontal cooperation, coopetition*

Conference Topic(s): *business models & use cases; technologies for interconnected logistics (digital twins, collaborative decision making)*

Physical Internet Roadmap*: ☐ PI Nodes, ☒ PI Networks, ☐ System of Logistics Networks, ☐ Access and Adoption, ☒ Governance.*

1 Introduction

Climate change is one of the major challenges of our generation. According to international figures [1], about 10% of global CO_2 emissions are related to the freight transport sector. Even more, up to 12%, if activities in hubs are included. Most of the emissions are related to road-based transport. It is therefore crucial to focus on a global reduction of transports. Those transports which cannot be avoided should be shifted towards more climate-friendly modes of transportation like the (inland) waterway system or rail system. The rest should be improved with respect to CO_2 emissions as much as possible. Possible technologies are (battery) electric vehicles and/or hydrogen trucks – as long as the energy/hydrogen is produced via renewable energy sources. However, replacing all trucks with electric trucks lets us face the same other challenges related with road transportation, which are, amongst others, congestion, soil sealing (for roads and parking places), noise, road safety, lack of truck drivers, driving time regulations, etc. Completely avoiding transportation is, however, not feasible from an economic point of view. Even though local production might be beneficial from different point of views, disadvantages are connected with it. E.g., not all raw materials are available in all regions. So, either certain areas around the world would have to deal without specific products, or transportation of raw materials, or manufactured goods is indispensable.

Taking a closer look at these aforementioned reasons, intermodal transports are to be intensified on a large scale. The basic principle of an intermodal transport is to split the transport into three legs: the first mile, the main run, and the last mile. While the first mile and the last mile are typically road-based, the main run is either completed via vessel or train. Obviously, capacities along the main run are much higher than on the first and last mile. Therefore, bundling has to take place in order to be economically viable. In addition, the first and last mile will most probably be below 150km. This is a distance for which state-of-the-art electric trucks can already be utilised. Therefore, intermodal transports contribute to all three aforementioned strategies in reducing CO_2 emissions: avoidance of transports (via bundling), shifting towards vessel/train, and electrification of those parts which have to be realised along the road.

Even though intermodal transportation seems to be a viable solution to an increasing freight transport demand, the question arises whether it is applicable on a large scale: As already mentioned, one crucial point is that critical masses of freight need to be transported along the same track as otherwise the usage of trains/vessels is not economically viable. This, however, implies (on a first glance) that only large companies with large amount of freight for the same route can utilise intermodal transportation. This is only partly true. Due to bundling of different freight flows, it is possible to generate the needed demand for transport along the main run on train/vessel. The coordination amongst the relevant stakeholders, i.e., the individual companies, is mostly done by carrier that order trains at railing companies that than take over the actual transport. Please note, that there is a number of various other constellations which, however, lead all to a similar structure: the actual transport executing company (operator) takes order from an intermediary (freight forwarder) that sells the capacities of the train to individual companies with “less than train” loads of freight.

All in all, this concept of transport bundling works quite well – from an economic point of view as well as from an individual point of view for smaller companies. However, the full potential is not reached yet by far. On the one hand, the modal split shows that road transport is still the most used mode of transportation – especially for intracontinental transportation, cf. [2]. On the other hand, the utilisation rate of individual trains and vessels differs and is not as high as it should/could be, cf. [3]. Goal of this work is to discuss how especially intermodal utilisation rates can be improved.

2 Proposition on Benefit Sharing

Within this paper, we propose the following: Instead of hoping that the current freight transport system will somehow improve over time, we propose to actively shape it. As outlined in the previous section, intermodal transports seem to be one major opportunity to overcome negative climate impacts from freight transportation (obviously, in combination with a lot of other measures, some of them not originating in the transport sector). As outlined, intermodal transportation relies on bundling of freight flows for the main run. Bundling, however, can be seen as horizontal collaboration between shippers. As (currently) this bundling is done via freight forwarders (or carriers), this is realised quite efficiently. However, if a freight forwarder (or carrier) does not gain enough orders to economically operate a train, it is most likely that all transports are realised on road. We suggest that in such cases, freight forwarders and carriers should (horizontally) cooperate with each other. For convenience only we outline our ideas for train operators only. Of course, the same mechanics apply for inland navigation.

2.1 Strategies for Horizontal Collaboration

Suggesting that freight forwarders and carriers cooperate with each other with respect to intermodal transportation, we outline the basic idea. The concept refers to the collaborative use of trains along the main run.

Based on expected freight volumes, individual freight forwarders should pre-order trains. First, they should pre-order trains for the main run on relations that will most probably be utilised on an economically viable level. In some cases, these trains will be fully utilised. In other cases, the utilisation will be close to economic inviability. However, the economic risk is low.

Second, trains should be ordered for relations, where companies themselves have a considerable volume even though the volume might not be enough for economic viability as long as others (i.e., competitors) have enough volume such that a joint transportation is economically viable. For those relations where the own volume is not considerable, the goal is to find operators which already ordered a train and put the own freight on that train, too.

So far, the proposed strategy is straightforward and only the joint transportation for relations where not enough volume for one company is available is cooperative. Even in this simple case, it is necessary to consider the benefits (e.g., saving time, saving costs) that are gained with such a strategy, and how these benefits can be fairly distributed amongst the participants.

At first glance, this need seems to be not mandatory, as the one company ordering the train (and then selling empty spaces to others) could make some money out of it. But to be honest, it can be expected that those companies in need of slots on a train are not willing to pay to their competitors. If, however, the costs and benefits are fairly distributed amongst all participants, the likelihood for cooperation can be assumed to be higher. We call this concept “Fair Benefit Sharing”.

Please note that normally, train schedules are not planned for just one trip, but for a recurring roundtrip for a longer period of time (e.g., one year). There might be some relations where all participants together do not have enough volume to justify such a block train. In such cases, a re-routing of transport units, i.e., containers, might be an interesting option. This means that instead of booking a slot on a direct train, slots on trains with a via-point are booked, e.g., instead of going from A to B, trains from A to C and C to B could be chosen. The operators of those trains do not necessarily be the same. The idea of such a re-routing of containers is depicted in [4]. First algorithms for optimising the decision which container is to be transported on which train are presented in [5]. With respect to benefit-sharing, this application scenario is just a multiple application of the above-described use case.

Another application case to be considered is the parallel operation of trains in the network. With parallel trains, we denote trains booked from different companies on the same relation/track. Over the course of a year, it is very likely that sometimes one of the two trains is full (or over-booked) while the other one has still some slots for containers left. In these cases, a shifting of non-transported containers for one company/train towards the other one (with still open slots) is beneficial as more customers can be satisfied while the utilisation rate of the second, non-fully booked train can be increased. Again, sharing costs and benefits among all partners will most probably increase the likelihood of cooperation among the competitors.

2.2 Benefit-Sharing

First of all, it is necessary to define what benefits are, exactly. In our understanding, benefits are the profits companies make with the transportation service. Please note, that other benefits, e.g., reduced environmental emissions, might be considered as well. For convenience only, we

focus on monetary benefits only in this paper. Contrary to the benefits are the costs which are the production costs of the transports, i.e., the fees for the tracks, the salaries of the train driver, the costs for the energy used, etc. With respect to share the benefits among all participants, we discussed several different formulas and ideas. Our considerations on how to distribute and share the benefits, led to one observation: Everyone has to bear its own costs. The benefits are then distributed proportional to the share of costs. I.e., someone with a 10% contribution to the costs, gets a 10% share of the benefit:

$$s_i = \frac{c_i}{\sum c_j}$$

The share s_i of participant i of the overall benefit is the fraction of their costs (c_i) and the overall costs of all participants ($\sum c_j$).

To ease computations of contributions and benefits, one can easily add up all costs (and profits) of each individual transport, i.e., the costs of the non-cooperative or status-quo approach. In addition, the costs (and profits) of the cooperative transports are calculated. The costs of cooperative transports are those costs that occur for all partners together when cooperative transports are applied. The difference between the overall individual transport costs and the overall cooperative transport costs is then the overall benefit. However, if the benefit is negative, i.e., the cooperative solution costs more than the individual ones, it is obvious that no cooperative transport will be executed. Please be aware that if for one participant cooperation is beneficial, it is beneficial for all participants when following this approach.

3 Expected Impacts and Future Work

We expect that this transparent and open calculation of benefits and the sharing of them will positively effect collaboration in the transport sector. Everyone participating in such a cooperative environment benefits proportional to his/her contribution. That is, no one is advantaged. On the contrary, the benefits are not only for the participants themselves who mainly benefit on a financial basis. The benefits are for all of us since the overall outcome are more environmentally friendly transports. That is, a positive contribution towards climate action. At the same time, the needed distribution of goods can be retained.

Even though in theory the solution is quite easy, the actual implementation is challenging. The most important issue is to build up trust among the participating parties. As some individual examples among different players show, such cooperations can be generated over time. However, they will always be on a rather small level. Therefore, we request that more effort is put into providing up technological support for trust-building. There are different transport management platforms on the market that allow booking, contract management, the recording of transport routes, availability display, usage times of assets, the search for offers for the customer, or documentation and evaluation of all desired events. One major need is that these platforms are neutral in the sense that they are not related to any transport companies. I.e., they are not operated or owned by transport companies (or some related to them). In addition, it is necessary that these platforms are transparent in how collaboration is facilitated and how benefits are shared amongst participants. Finally, they need to be open, i.e., all parties who want to participate, do get easy access. Of course, some quality and anti-fraud checks need to be integrated into them, but they should not limit access to the platform for well-meaning and honest players.

4 Conclusions

Within this work, we briefly discussed the need for fair benefit sharing in the freight transport sector. The presented approach is based on the observation that a distribution of benefits gained through distribution should be shared among the stakeholders proportional to their contribution (i.e., individual costs). This leads to the observation that either collaboration benefits for all participants, or for nobody. The latter will, obviously, result in a non-collaboration approach. It is, however, important to note that the decision whether (or not) collaboration is beneficial, can be made on a per-case level. I.e., for each possible collaboration, a new decision can be made. As this decision making will be time-demanding when manually performed, we propose to utilise transport management platforms. They need, however, to be neutral (i.e., not owned or operated by any company interested in the transports themselves) and open (i.e., anyone who wants to participate is able to do so – as long as the party is well-meaning and no fraud).

It may be argued that (in a future) scenario there will be no need for (complex) benefit sharing algorithms as most of the transport will be organised via concurrent protocol-based cooperations. Although we think that this statement is true, we have two remarks to add. First, we think that benefit sharing will be one component of these future protocol-based cooperations. Second, and most probably more important, we think that a transition towards a future set-up is necessary. And this transition phase will require transparent benefit sharing algorithms, as the freight transport sector currently is marbled by mistrust. We are, however, positive that once the transition phase started on a large scale, very soon the mistrust will change into trust and the anticipated positive impacts will soon take place.

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