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A Concept for Situation- and Demand-Responsive Collective Passenger Information in Regional Trains

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Abstract

Today's collective information systems in trains of local and regional transport in Germany appear rather outdated. The information offered often only corresponds to the requirements of authorities and laws. Long-term contractual periods and proprietary systems prevent innovation. Current product inventions and the benefits of digitalisation help to find new approaches in order to create contemporary, passenger-oriented and attractive possibilities to transfer information of different kinds to the passengers. Therefore, the aim of this research is to develop a concept for collective passenger information which is dynamic, flexible, situation-responsive and demand-responsive, and which ensures a contemporary transfer of needed information while fulfilling all formal regulations by authorities.

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Keywords: Passenger Information; Demand Management; Traveller Information Systems; Train Operations; Passenger Demand;

1. Introduction

In times of smart mobile devices and personalised travel information, the value of collective passenger information systems can be easily underestimated. To comply with requirements of transport authorities and to deliver valuable information to a great share of passengers, on-board information systems still obtain vital importance concerning passenger guidance, orientation and comfort. However, previous forms of passenger information in German local and regional trains via small TFT-monitors, LED matrix displays, and acoustic announcements appear rather outdated. Long-term contractual periods and proprietary systems prevent innovation. Current product inventions and the benefits of digitalisation convey several approaches to create contemporary, passenger-oriented and attractive

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possibilities to transfer variable information to the passengers. Therefore, an innovative concept for flexible situation- and demand-responsive collective passenger information in regional trains has been developed as a method to provide contemporary transfer of needed information. This concept has the ability to adapt the information program to the actual situation of each train.

To transfer the most required information via different types of visual and audio media devices in the vehicle, it has to be known which kind of passengers are travelling in the considered train. Therefore, stereotypical groups of different passengers are defined by using the persona method. Each of those different stereotypical passenger groups, e.g. commuters, elderly people or tourists, has different values of previously defined attributes which lead to a varying demand for information. But even passengers from the same stereotypical passenger group have different information demands based on their individual travel phase, e.g. orientation phase after entering the train or arrival phase. Therefore, different passenger-related travel phases are defined. In order to create a high benefit for the passengers, the information needs to be adaptable to current external effects, such as delay, weather conditions etc.

To create information programs based on several types of passengers in different travel phases, each information item needs to be associated with the defined attribute values. In combination with the current passenger share, an "individual information demand value" is found which represents the relevance of each information item based on the overall demand of passengers in the considered situation. In the German public transport system, specific elements of collective passenger information are required by regional public authorities and the European Union. To fulfil those authority regulations, this weighted value needs to be corrected for different train-related travel phases. Thereby, an information program can be created which consists of prioritised information based on the situative demand of the current passenger composition. Finally, to present the prioritised information to the passengers, a method needs to be developed which is able to create sequences of appropriate flexible time slots for all individual information.

This paper explains those different steps towards a flexible situation- and demand-responsive information program as well as initial approaches for an agile information sequence creating method.

2. Definitions and fundamentals

2.1. Situations

To determine which information is needed in a specific situation, the current situation needs to be characterised as accurately as possible. Apart from that, specified and defined input variables are required to make situations comparable. A situation, in accordance to this research, is defined as the simultaneous occurrence of various input variables which affect the demand- and situation-responsive passenger information in the train. Such variables are, the considered vehicle, time, location and specific events. In this research, two types of situations are distinguished: "basic situations" and "special situations".

Basic situations represent situations in which a regular operation following the train schedule is possible. Through differential values of defined attributes, distinct basic situations can be described in detail. Considered input variables are:

- Vehicle
- Time
- Location
- Operational conditions

Special situations represent situations in which a regular operation by following the train schedule is not possible. To describe special situations, distinctions are made between causes for a special situation and its impacts on the journey. Considered causes are:

- Natural Causes
- Incidents
- Local Events

It is assumed, that the impacts of a special situation on the travellers are more important for the passenger information. Therefore, different impacts are considered:

- Deviations at the next train station
- Deviations of the journey
- Connection protection
- Operational deviations

All those input variables and their values are compiled in a morphological box which allows the description of the current situation (Figure 1).

Influence Basic Situation		Vehicle	Regional Train	Regional Express	Suburban Train			Others		
Influence Basic Situation		Time	Morning peak hour	Evening peak hour	Weekend		School holidays	Working day	Night	Public holiday
Influence Basic Situation		Place	Metropolitan area	Suburb		Rural area	Airport	Exhibition centre	Event centre	POI
Influence Basic Situation	Operational Requirements	Frequency	Very High		High	intermediate		low		
Influence Basic Situation	Operational Requirements	Temporal distance bewteen two stations	Short			Intermediate			Long	
Influence Basic Situation	Operational Requirements	Average length of stay of passengers in the train	Short			Intermediate			Long	
Cause of Special Situation			None	Natural Cause		Incident		Local Event		Others
Effect of Special Situation		Deviation at the next Station	None	Modified Passenger Guidance		Changed Platform		Station cancelled		Others
Effect of Special Situation		Impairment of travel	None	Impairment of comfort		Impairment of travel time		Impairment of travel route		Vehicle exchange
Effect of Special Situation		Connection protection	None			Active connection protection			Passive Connection protection	
Effect of Special Situation		Operational deviation	None	Special transport	Limited traffic		Schedule changes		Others	

Figure 1: Describing Situations - Morphological Box

2.2. Personas

It is assumed that various kinds of people are having a different information demand in a considered situation. Unfortunately, it is not possible to consider the demand of every single person in the train. However, to consider a significant share of obtained passengers, the persona method is used. The persona method was introduced by Alan Cooper in 1999 and is used to make an intended user the centre of attention, according to Elbeshausen et al. (2013). In this research, stereotypical groups of passengers are defined by means of a single persona. Personas are having several different attributes which are influencing the information demand of every single persona. In order to fulfil those demands, a series of basic information or special information is needed.

In this research, nine different personas are considered:

- Commuters
- Business travellers
- Students
- Families
- Elderly people
- Tourists
- Aliens to the system
- Leisure-oriented people and locals

The information demand of a persona, and by this the demand of a stereotypical passenger group, depends on different value expressions of defined attributes such as the dependency on public transport, the degree of missing experience in the public transport system, or requirements concerning comfort, reliability, punctuality and others.

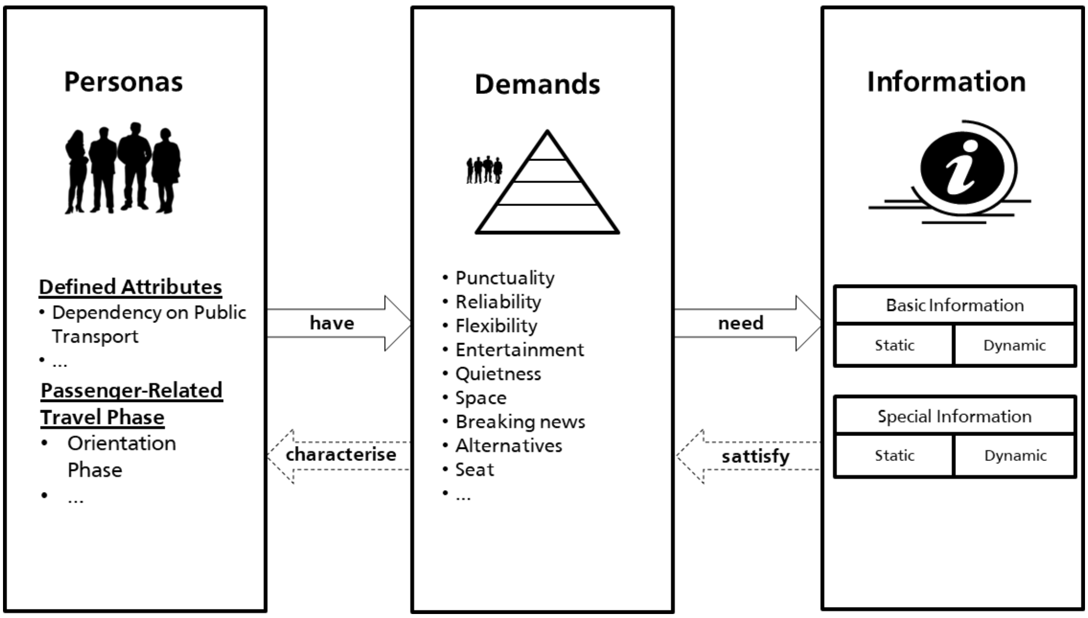


Figure 2: Classification of personas, demand and information

2.3. Passenger-related travel phases

Passengers are demanding different information in different passenger-related travel phases. In order to assess the demand of each persona during its journey, four different passenger travel phases are defined:

- **Orientation phase (OP)**: The orientation phase starts at the moment the passenger could be reached with the on-board information system of the considered train. These probably will be the displays or indicators on the outer shell of the train. Because this research only considers vehicle on-board systems, information provided by mobile devices or collective media in the station are not considered.
- **Departure phase (DP)**: The departure phase starts as soon as the travellers enter the train, and it endures until they found their prior position in the wagon where they want to stay. It is assumed that the attention of passengers is devoted especially on their orientation, e.g. on finding a seating position. Thus, according to Wickens (1980) it is assumed that their attention for other information is limited.
- **Main travel phase (MTP):** The main travel phase starts as soon as the travellers decide to stay at the current position in the wagon. The considered travellers have now positioned themselves in the vehicle. It is assumed, that the passenger attention on collective information varies depending on their experience with this particular train connection.
- **Arrival phase (AP):** The arrival phase starts with the first intention of the travellers to leave the train at the next station. This intention could be triggered by own orientation within the journey or be influenced by passenger information. The arrival phase ends as soon as the travellers leave the train.

3. Concept development

3.1. Assessment of demand

In this study, several matrices were created to assess the demand of the passengers for each specific information item in all different situations. In those matrices, qualitative assumptions were made which then were audited by several other experts. Assumptions and audit results were discussed afterwards, to get a realistic representation of values. At a later stage, it is planned to verify the values by passenger surveys. Overall, more than 2500 values were created describing the specific information needs of passengers in different situations.

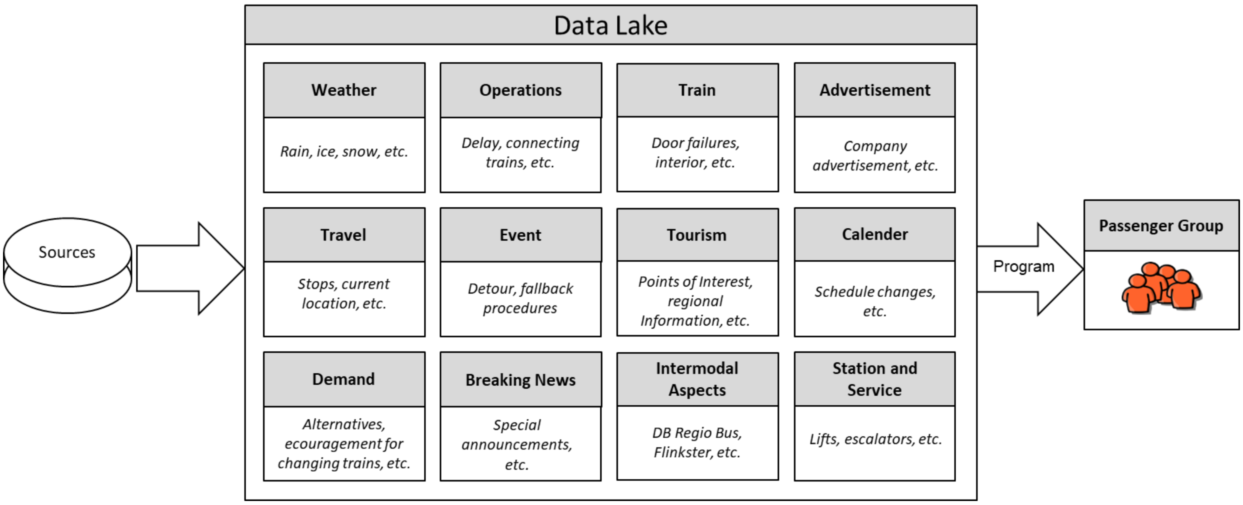


Figure 3: Data Lake with possible information items

In the first matrix, as shown in Figure 4, it is determined, which kind of attribute value expression is considered for which passenger-related travel phase for each persona. The applied scale distinguishes three different expressions for each attribute. Besides that, a matrix is created in which all different value expressions are assigned to specific information. Therefore, a list of 102 different possible information items was generated previously, including information sets for train operation, incidents, weather conditions, and many others. Those information sets are called “information container” and are subdivided into different categories. All information containers combined create a data lake, in which all information is stored which could be considered for passenger information in the train (Figure 3).

Combining those two matrices, a third matrix is created which shows the information that is needed for each persona for all passenger-related travel phases (Figure 4: Assessment of demand 4). These created values are used later as initial data to develop a prioritised list of information in the considered situation.

For example, the information item iii in Figure 4 could be the information for free seats in the train. Both personas have a demand to sit down during the travel. The need for information about empty seats is assumed to be mainly expressed in the orientation phase and the departure phase. Therefore the information item “free seats” should be transmitted in these passenger-related travel phases to satisfy the demand.

	Persona A				Persona B			
Travel Phase	OP	DP	MTP	AP	OP	DP	MTP	AP
Demand 1	✓	✓	✓	✓	✗	✗	✗	✗
Demand 2	✗	✗	✗	✗	✓	✓	✓	✓
Demand 3	✓	✓	✗	✗	✓	✓	✗	✗

	Demand 1	Demand 2	Demand 3
Information Item i	✓	✗	✓
Information Item ii	✓	✗	✗
Information Item iii	✗	✓	✓

	Persona A				Persona B			
Travel Phase	OP	DP	MTP	AP	OP	DP	MTP	AP
Information Item i	✓	✓	✓	✓	✗	✗	✗	✗
Information Item ii	✓	✓	✓	✓	✓	✓	✓	✓
Information Item iii	✓	✓	✗	✗	✓	✓	✗	✗

Figure 4: Assessment of demand

3.2. Structure of demand- and situation-based passenger information

Figure 5 provides an overview of the structure and requirements in passenger information.

General requirements set the basis for demand- and situation-responsive passenger information. Those requirements occur in every situation and, therefore, are described as invariable. Following the guidelines of the German Road and Transportation Research Association (FGSV) (2009), the successful use of passenger information is depending on the information accessibility by passengers. Therefore, passenger information should have high availability and has to be accessible independently from the passengers’ location. Information on all media devices (static and dynamic) should have a high topicality and reliability. Information updates should orientate towards the passenger demands. It is assumed that too much information complicates the passengers’ orientation. According to that, the right quantity needs to be ordered by the journey and priority.

Building on this basis, additional requirements for personalised passenger information are set. Following the new European General Data Protection Regulation (GDPR) Article 5, personal data shall be *"processed in a manner that ensures appropriate security of the personal data, including protection against unauthorised or unlawful processing and against accidental loss, destruction or damage, using appropriate technical or organisational measures"*. According to the German Federal Office for Information Security (Bundesamt für Sicherheit in der Informationstechnik – BSI) (2012), this especially includes confidentiality and integrity. This research focusses on collective information systems, therefore personalised passenger information is not further examined.

Based on those requirements, stereotypical passenger groups and situations are considered to generate multiple demands. Because demands not only depend on attribute expressions of a passenger but also on the current situation, there is no strict separation in Figure 5. On the contrary, transmitted passenger information should base on the composition of various stereotypical passenger groups, passengers in different passenger-related travel phases, different train-related travel phases and many input variables of the current situation.

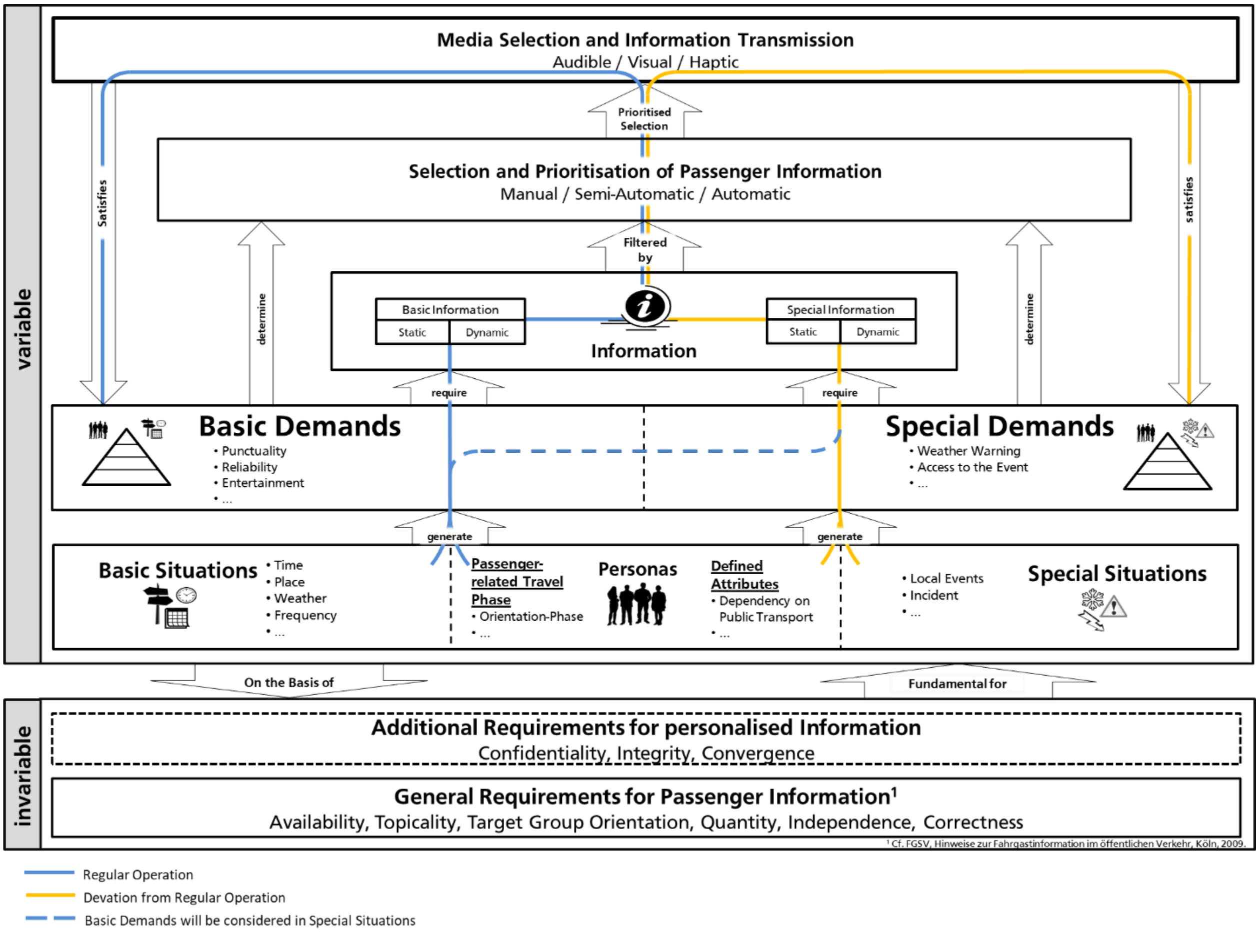


Figure 5: Passenger Information – Structure and Requirements

Series of information is needed to satisfy current information demand. Such series consist of basic information and special information. In a basic situation, only basic information is required. In special situations, special information is necessary while basic information is still regarded. In each situation, demand assessments and information prioritisations have to be made.

To avoid information overload and the transmission of irrelevant information, a selection of prioritised information has to be made. Prioritisation and selection can be conducted manually, semi-automatically or, with appropriate algorithms, fully automatically. A prioritised selected list of information then could be transmitted to the passengers via various types of media. By transmission of the “right” information, the information demand of the passengers gets satisfied. Basic demand and special demand depend on many varying factors and, therefore, are referred to as “variable”.

3.3. Development of a method to prioritise single passenger information

To transmit the information with the highest demand without neglecting authority regulations, it is necessary to prioritise the individual information from the data lake. Therefore a method was developed, which is based on the demand of the passengers in the train and which could be corrected to fulfil authority regulations. The procedure sequence is shown in Figure 6.

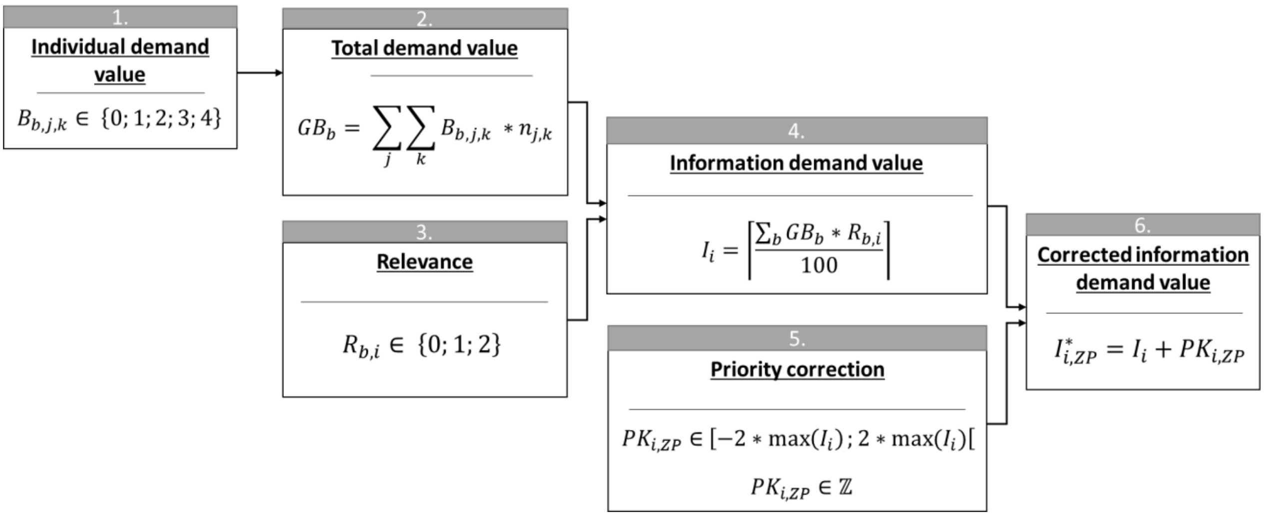


Figure 6: Sequence of prioritising information items

B	Individual demand value	j	Stereotypical passenger group (persona)
b	Considered demand	k	Passenger-related travel phase
GB	Total demand value	n	Number of passengers
I	Information demand value	PK	Priority correction
I*	Corrected information demand value	R	Relevance
i	information item	ZP	Train-related travel phase

The nomenclature for the equations has been developed for German language and may not correspond with English wording.

The basis for this method is set by the current situation. In accordance with this situation, the individual demand value of the considered passengers is assessed. The individual demand value (B) is set for every new situation and indicates how strong the considered demand (b) is related to a stereotypical passenger group (j) in a passenger-related travel phase (k). The scale reaches from zero as “demand is not expressed” to four as “demand is very highly expressed”.

$$B_{b,j,k} \in \{0;1;2;3;4\} \tag{1}$$

The individual demand value needs to be assessed for every occurring demand. Basic situations require the assessment of basic demands as special situations require the assessment of special demands.

By combining those individual demand values, a "total demand value" (GB) can be determined which expresses the overall demand in the considered situation for all stereotypical passenger groups and passenger-related travel phases. Therefore, the number of passengers of a stereotypical passenger group within a passenger-related travel phase (n) is firstly multiplied by the individual demand value. Those interim results are then summed for all stereotypical passenger groups and passenger-related travel phases:

$$GB_b = \sum_j \sum_k B_{b,j,k} * n_{j,k} \tag{2}$$

The total demand value indicates how strongly single demands (b) are expressed in the considered situation for all passengers on the train.

To determine which information is needed to satisfy this total demand it is necessary to assign the relevant information to the demand. To do so, the relevance for each information item is assessed qualitatively on a scale from zero ("not relevant") to one ("relevant") and two ("highly relevant").

$$R_{b,i} \in \{0;1;2\} \tag{3}$$

The resulting matrix only has to be built once and could be used for every situation. Therefore it is suggested that the assessment is done by experts in the relevant field and area.

By combining the total demand with the relevant information, it is possible to create the "information demand value". The information demand value describes the information which serves to satisfy the total demand of the passengers in the considered train and situation. To create this value, the total demand and the information relevance are brought together. To calculate the information demand value (I) of information items (i) firstly the product of information relevance R and total demand value GB is calculated. The summed products display the demand of individual information on the train. Because these results could appear as rather big numbers, the estimated sum is divided by 100 and rounded up to the next integer to get evident values.

$$I_i = \left\lceil \frac{\sum_b GB_b * R_{b,i}}{100} \right\rceil, \quad I_i \in \mathbb{Z} \tag{4}$$

A sorted information list ranked by the information demand value creates the content of an information program which represents the weighted information demand in the train.

Due to many circumstances, e.g. authority regulations or laws, it is necessary to transmit specific information items to the passenger by any means. Even if this information does not satisfy or just slightly satisfy the total demand, it needs to be transferred. To comply with such regulations, a "priority correction" (PK) is necessary. The priority correction assigns specific information with distinctive surcharges und discharges. These corrections depend on the train-related travel phases (ZP).

To ensure evident priority corrections, it is recommended to orientate the corrections towards the information demand value without exceeding the double maximum or the double negative maximum of the information demand value. To allow extremely relevant information to get on the top of the weighted information program (e.g. rescue information in cases of emergency), the interval is open towards the maximum.

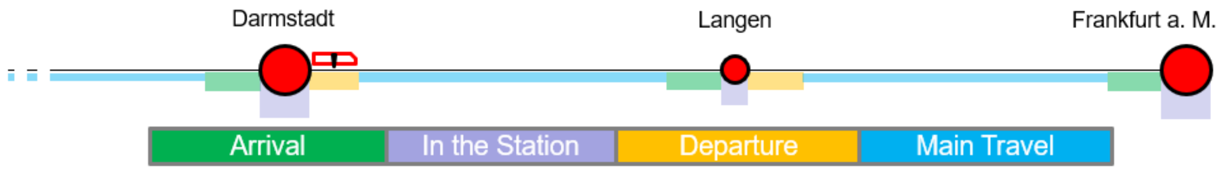
$$PK_{i,ZP} \in [-2 * \max(I_i) \,;\, 2 * \max(I_i)[,\qquad PK_{i,ZP} \in \mathbb{Z} \tag{5}$$

Totalizing the information demand value and the priority correction, the "corrected information demand value" (I*) is generated. A sorted information list ranked by the corrected information demand value creates the content of an information program which can be transmitted to the passengers.

$$I^*_{i,ZP} = I_i + PK_{i,ZP} \tag{6}$$

3.4. Practice-oriented application

The aim of this research is not just to create a correct mathematical procedure, but to create plausible passenger information programs, which could upgrade the current status of passenger information systems in trains. To consider whether the prior described approach is practically useful it needs to be tested in practice. Therefore, a train connection between the two German cities Mannheim and Frankfurt am Main was examined for its currently operating passenger information. By observations in the real train run, the information items transferred to the passengers in a basic situation were investigated. Afterwards, the algorithm described in this paper was applied for different situations along the same travel. Three different conditions were chosen, each for a basic situation as well as for a special situation: commuter traffic, leisure traffic and urban centre traffic. To investigate the behaviour of the algorithm, the composition of the passengers in different passenger-related travel phases as well as the train-related travel phases were changed.



Last Phase	Current Phase	Next Phase
Punctuality	Start/Destination	Start/Destination
Planned Departure	Planned Arrival	Planned Arrival
Line	Planned Departure	Planned Departure
Start/Destination	Punctuality	Punctuality
Planned Arrival	Information for Orientation in the Train	Predicted Arrival
Actual Departure	Predicted Arrival	Line
Seat Reservations	Line	Actual Departure
Predicted Arrival	Seat Reservations	Information for Orientation in the Train
Connection Options	Position on the Train Run	Position „on the Map"

Figure 7: Example for prioritised passenger information in a basic situation

The comparison was demonstrating that the algorithm delivers plausible results for basic situations (compared with currently installed passenger information systems, see Figure 7) but still needs to be refined for special situations. The aim of refinement should be a higher detail degree ("resolution") of the current special situation which can distinguish between several different special situations. This is necessary because different special situations require different information.

3.5. Form of information transmission

The choice between acoustic and visual information transmission is highly dependent on the priority of the information. According to Lehnert (2004) the ability to memorise information varies depending on the sensory channel of the passengers:

- 10 % by reading
- 20 % by listening
- 30 % by seeing
- 50 % by hearing and seeing

Furthermore, additional findings of Riedl (2004) show that only 11 % of the overall information is absorbed by hearing while 83 % are absorbed by seeing.

Based on those findings, it is suggested that critical information is transmitted via two different sensory channels (seeing and listening). Visualisation of information, e.g. with pictograms, raises the ability to absorb information. If two sensory channels are used, the individual information must not conflict with each other.

Additional requirements regarding the form of information transmission depend on the public transport authority or the local law. Those requirements may be raised by the needs of people with reduced mobility or limited sensual perception. In the European Union, requirements for information in the railway system are, among others, regulated in the Commission Regulation (EU) No 1300/2014. This regulation provides that:

- The information system must be able to transmit information in foreign language.
- When using automatic systems, it needs to be possible to correct or to suppress wrong or misleading information.
- The display design and positioning shall orientate to the maximum reading distance. The font size in displays is derived by the following formula:

$$Font\ Size = \frac{Maximum\ Reading\ Distance\ [mm]}{250} \tag{7}$$

A passenger information program is designated as the combination and chronological sequence of information items during the travel. Following the EU Commission Regulation, the duration has to be at least 2 seconds for each information item. The maximum period of a program depends on various factors, but particularly on the time left to the next station. Depending on the period of the program, it is possible to insert more or fewer information items with a flexible duration which depends on the priority. A sequence must be able to be interrupted to include emergency information. Therefore technical infrastructure and software must be able to react flexibly and agile on the occurring situation

3.6. Media positioning

During the research, visual and audible media devices were examined. For dynamic **visual** information the following provisions have to be considered following the Commission Regulation (EU) No 1300/2014:

1. *“The final destination or route shall be displayed on the outside of the train on the platform side adjacent to at least one of the passenger access doors on a minimum of alternate vehicles of the train.*
2. *Where trains operate in a system, in which dynamic visual information is given on the station platform every 50 m or less, and destination or route information is also provided on the front of the train, it is not mandatory to provide information on the sides of vehicles.*
3. *The final destination or route of the train shall be displayed inside each vehicle.*
4. *The next stop of the train shall be displayed such that it can be read from a minimum of 51 % of passenger seats inside each vehicle including 51 % of the priority seats, and from all wheelchair spaces.*
5. *This information shall be displayed at least two minutes before arrival at the station concerned. If the next station is less than two minutes planned journey time away, the next station shall be displayed immediately following departure from the previous station.*
6. *The requirement to make the destination and ‘next stop’ information visible from 51 % of passenger seats does not apply to compartment carriages where the compartments have a maximum of 8 seats and are served by an adjacent corridor. However, this information shall be visible to a person standing in a corridor outside a compartment and to a passenger occupying a wheelchair space.*
7. *The information about the next stop may be displayed on the same support as the final destination. However, it shall revert to show the final destination as soon as the train has stopped.*
8. *If the system is automated, it shall be possible to suppress or correct incorrect or misleading information.*
9. *Internal and external displays shall comply with the requirements of point 5.3.2.7. In this point, the term ‘display’ shall be understood as any support of dynamic information. “*

For dynamic **audible** information the following provisions of the European Commission (2014) have to be considered:

1. *“The train shall be fitted with a public address system which shall be used either for routine or emergency announcements by the driver or by another crew member who has specific responsibility for passengers.*
2. *The public address system may operate on a manual, an automated or pre-programmed basis. If the public address system is automated, it shall be possible to suppress, or correct, incorrect or misleading information.*
3. *The public address system shall be capable of announcing the destination and next stop of the train at each stop, or on departure from each stop.*
4. *The public address system shall be capable of announcing the next stop of the train at least two minute before the arrival of the train at that stop. If the next station is less than two minutes planned journey time away, the next station shall be announced immediately following departure from the previous station.*
5. *The spoken information shall have a minimum STI-PA level of 0.45, in accordance with the specification referenced in Appendix A, index 5 [Commission Regulation (EU) No 1300/2014]. The public address system shall meet the requirement at all seat locations and wheelchair spaces.”*

The aim of this research is the development of an integrated information system. Therefore, visual and audible media devices have to be positioned in a way, that all of the prior described provisions are followed. However, additional media devices could be used to complement the information offered in the train. Additionally, it is suggested to position media devices in places where the position of individual information supports its content.

In the research, so far, only regional trains were examined. The devices for dynamic visual information appeared rather small and less distributed in the wagons. However, these wagons offer plenty of space to place information, e.g.:

- Partition walls and ceiling area
  (wagon capacity utilisation, orientation in the train etc.)
- Floor area, stairs
  (seat load factor, orientation in the train etc.)

- Upper baggage area
  (seat load factor, orientation in the train etc.)
- Windows, tables
  (Points of Interest, personalised information etc.)
- Entrance area and doors
  (orientation in the train and the next station, exit information etc.)

3.7. Outlook on further research

After developing the first draft for a demand- and situation-responsive concept for flexible passenger information, further research is needed to evaluate findings and to enable the concept for practical application. So far, the concept and the value assessments base on various assumptions concerning traveller demand and behaviour. To get realistic data, a customer survey needs to be done. On this basis, all assessments need to be evaluated and may be reassessed. To create an added value on today’s collective information systems, the developed algorithm needs to be refined in order to prioritise information items all occurring situations.

To implement the algorithm into a practically operated passenger information system, it is vital to detect the amount and the composition of passengers in the train. Therefore, another research currently investigates the applicability of automatic passenger counting systems as well as historical data, sales data, mobile network data etc. in order to get the required input for the algorithm. In addition, information on the current situation, e.g. delays, weather condition or other issues relevant for situation-sensitive passenger information, must be captured. Based on such data feeds, an agile algorithm can be developed and calibrated to adapt the information system contents flexibly to the current situation and the presumed or detected passenger composition.

Once these further developments are made, a more efficient and effective collective passenger information is possible, basing on the introduced concept which can be transferred to almost any other public transport vehicle. Furthermore, the general approach of assessing the specific and situation-dependent information needs of different traveller groups may also be useful to improve individual passenger information systems.

So far it has not been possible to ensure contemporary passenger information in many German regional trains. The considered information systems cannot be modernised easily since they are part of proprietary systems of the trains. Current maintenance contracts with the train manufacturers do not allow the operator to change installed systems without permission. To achieve innovation, it is necessary to dismantle such barriers and to expand the operational possibilities of the operators. Therefore this ongoing research also aims to point out deficiencies, such as currently closed interfaces, to enhance future innovation in passenger information systems of German regional trains.

3.8. Conclusion

Today’s collective information systems in trains of local and regional transport in Germany appear rather outdated. The information offered often only corresponds to the requirements of authorities and laws, but it is not sufficient to satisfy the information needs of various passenger groups in different situations. Therefore, this research not only regards individual parts of passenger information systems, such as displays or other media devices, but the whole system from information source to information sink. To create the most valuable collective passenger information, the passengers and their demands are in the focus of this research.

In order to increase the flexibility of passenger information, a concept was introduced, which is able to create passenger information programs on the basis of the current situation and passenger composition. In terms of customer service quality, demand- and situation-responsive passenger information leads to a more customer-oriented operation and, therewith, supports corporate objectives such as customer satisfaction and innovation.

So far, the concept and assessments of passenger demands are based on various assumptions concerning traveller demand and behaviour. All assumptions were made using the persona method and had been reviewed by experts in the field. To refine the developed algorithm, a passenger survey is conducted to evaluate and reassess all assumptions with examined values.

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