NEW METHODS AND THE TECHNOLOGY FOR THE IMPROVEMENT OF TRANSIT AUTHORITY MANAGEMENT.

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1. INTRODUCTION AND STATEMENT OF PROBLEM

In order to fulfil their task of transporting passengers reliably, safely and economically, the transport companies in the public transit sector require a considerable amount of information and data of different types. Collection and processing of information in these companies is still carried out manually to a large degree. The information flow depends mainly on personal commentary, telephoning and the filling in of forms and distribution of paper. Data collection and processing is carried out manually by procedures such as : making notes, filing, looking for data and assessing it by inspection. The results suffer from a lack of effectiveness, characterized by increased time for processing, fragmentary results, increased use of materials and low capacity utilization.

Technological progress of the last few years in the field of microelectronics and data processing have made it possible to introduce high performance data processing equipment to process and deal with a whole series of tasks also in the public transit sector.

However the development of standardized application software is causing great problems today, and not only in the public transit company sector. Firstly, it can be seen that software development is getting more and more expensive in comparison to hardware costs. For this reason alone, small and medium-sized companies especially, are faced with insurmountable obstacles when it comes to introducing E D P aids to their operations.

Aside from the question of costs another immediate problem is the availability of sufficiently qualified personnel from within the organization. There may be experts within the company capable of organizational preparation, defining the function and formulating the operational requirements, who cannot, however, be released from their tasks in office and workshop to a sufficient degree.

Within transport companies, the first applications of new technology and EDP aids can be found in the fields of administration and operations control.

In the administrative sector, EDP equipment is especially used for processing tasks in the book-keeping, buying, inventory and personnel departments.

In the operations control sector, original, new systems are being developed or are already available for practical applications, e.g. command and control systems, vehicle diagnosis systems, passenger information systems and a whole range of peripheral electronic equipment.

As we know today, these individually developed systems can only be transferred to other transport operations with substantial adaptation and at a great cost. Even where adaptation is possible and is carried out, the system does not lose its relationship to the original solutions of the fundamental individual problem for which it was designed. This results in insular solutions and ad hoc developments essentially designed to fulfil the demands of the developer and not able, or rather, not yet able to be integrated into a system.

The following remarks can therefore be divided into two sections:

The first part consists of an overview of operations control and information technology either currently available or shortly to be taken into operation.

The second part looks at possibilities and first results in the development of a standardized, modular operations control and information system for companies in the public transit sector.

1.1 OVERVIEW OF CURRENTLY AVAILABLE OPERATIONS CONTROL AND INFORMATION TECHNOLOGY

All systems and equipments which collect data, store it or process it and provide information belong to the sector of operations control and information technology.

1.2 COMMAND AND CONTROL SYSTEMS FOR DRIVER OPERATED VEHICLES IN LINE HAUL SERVICE

In this group there are several independently developed systems (e.g. "BON", "LIO", "TELETRANS", "SELBUS") all of which provide the following services or fulfil the following functions for road sharing vehicles such as buses or trams:

1.) Automatic locating of vehicle on a predeterminded track, running to schedule, by means of the number of wheel revolutions, defined sections of track and/or locational markings.

2.) Automatic comparison of "planned time/real time" with incoming location reports and timing with "planned" timetable data. Deviations are reported not only to the driver in the vehicle but also to controllers at the command centre by means of suitable visual and acoustic equipment so that the necessary measures can be taken.

3.) Simplified radio communication between the driver and command centre by means of transmitting codes and transmitting specific information at the push of a button.

These functions are supplemented by a computer which edits, classifies, supplements and stores all data. Together with visual displays, printers, additional storage and other peripheral equipment, it provides an effective aid for supervising and controlling operations for the personnel of the central control.

1.3 COMMAND AND CONTROL SYSTEMS FOR DRIVER OPERATED VEHICLES IN DEMAND MODE

These systems, especially "RUFBUS" and "RETAX" were developed for the control of demand actuated bus systems which basically do not function according to a fixed timetable and route.

A prerequisite for the effective functioning of these systems is trip request information from passenger to control centre. The operation is automated as follows:

1.) Automatic trip request collection via call terminal.

2.) Automatic supervision of trip requests via a central computer in the control centre.

3.) Automatic placement of ride order, vehicle supervision and communication between driver and control centre via a radio transmission control unit.

Aside from up-dated operational data, the computer supplies comprehensive information about operational quality and results.

1.4 COMMAND AND CONTROL SYSTEMS FOR AUTOMATICALLY GUIDED VEHICLES

Two systems need to be mentioned here, "PUSH" and "SELTRAC", both of which have been under test in passenger service for several months.

They are computer controlled systems for operations control of automatically guided track-bound vehicles in the public transport sector.

The tasks of operations control are fulfilled at the three following functional levels:

1.) The system supervision level takes care of control and supervision tasks. The controller at the command centre receives all important operational data. In cases of interference or malfunction, he can take direct action.

2.) At the system control level, actual operations are controlled, such as: assembling and disassembling of trains, track control and schedule adherence.

3.) The process level is embodied by the vehicles and interlocking machines. Control and supervision of vehicle functions such as automatic driving and braking, belong at this level.

All communications equipment such as, colour monitors, alpha-numeric displays, synoptic boards, telex, radio and telephone equipment belong in the system supervision level.

1.5 PERIPHERAL EQUIPMENT IN COMMAND AND CONTROL SYSTEMS

A whole range of equipment is involved here, which basically fulfils the functions of passenger processing and which collects a large quantity of data needed at many different points throughout the whole undertaking. The following are a few examples of such equipment: Equipment to register passenger boarding and deboarding by means of air pressure, light-beam or foot-mat systems; ticket automats, ticket punching machines with remote control and electronic data collection and storing capability; passenger information systems at stations and in vehicles.

1.6 OTHER INFORMATION SYSTEMS

The "AFI" system plays an important role in the passenger information sector. This is an automatic information system which provides passengers on demand with information as to favourable ride connections, type of vehicle and vehicle number, departure, transfer and arrival times with relevant data as to station and ticket prices. The information is received either by telephone at home with synthetic voice reproduction or printed at an information automat.

A further important role in the sector of information systems, this time in the field of vehicle maintenance, is taken by external and internal vehicle diagnosis and tank data collecting systems. With the aid of induction transmitters, thermo-sensors, check wiring etc, measurement data is collected, stored and evaluated from a wide variety of components.

1.7 PURE SOFTWARE DEVELOPMENT

Aside from the operations control and information systems already mentioned, which all require development of special hardware as well as system software, some developments in pure software should be mentioned which have been designed for companies in the public transit sector.

EDP systems are used in a relatively large number of transport companies in the purely administrative sectors. This has two reasons:

Firstly, many transport companies in the FRG are municipal companies working in association with electricity, gas and water works. The administation of these municipal services is carried out centrally and especially the utility companies require EDP systems for billing customers.

Off-the-peg EDP programmes for purchasing, sales, book-keeping and personnel affairs are available for solving administrative problems from other commercial branches. EDP solutions to problems specific to transit companies have been developed for scheduling, round-trip planning and rostering. There have been several parallel developments here, ranging from interactive aids to fully automatic systems.

These programmes are already available but are being used essentially in developing companies at present. Here the problem of such developments can be seen: Systems developed initially according to one operator's wishes can not be transferred to other companies requirements without some considerable adaptations.

It is particularly problematic if several programme and information systems have to be introduced in parallel in one company. Due to differing software development and data structure it is not possible, for example, to revert to one data file if the same data is required.

2. DEVELOPMENT OF A STANDARDIZED, MODULAR OPERATIONS CONTROL AND INFORMATION SYSTEM FOR THE PUBLIC TRANSIT SECTOR

With the central development of a standardized operations control and information system, which ensures coordinated operation of modular constructed system components within a complete system, it is intended to offer the transport companies a professional and economic aid.

The system components should be developed, right from the beginning, for a broad spectrum of users, and the necessary software should concentrate on specific tasks and problems. With its modular form and individually designable interfaces, specific wishes of the user, governed by such variables as size differences, differences in transport systems and conceivable differences in organization should be catered to. Unnecessary partial functions should be omitted and additional requirements included via user interfaces.

Prerequisite to development of such an operations control and information system is the creation of a standardized task and data flow structure for transport companies and the definition of suitable problem areas for useful system components.

In order to do this, tasks must be examined in the framework of a structure analyses in individual companies according to type, frequency and aim, and functions and procedures checked systematically to see if they can be standardized.

Precisely this has been done in a research and development project commissioned by the Federal Minister of Research and Technology and completed by the SNV Studiengesellschaft Nahverkehr mbH in Hamburg a few weeks ago.

A few words should be mentioned here about the results of the study:

On the basis of data requirement and information flow analyses in six transport companies individually representing entire groups, "basic functions" and "tasks" of a transport company were set out in a "nominal structure".

The transport companies were firstly sub-divided into the four operational sectors: "Administration", "Operation", "Vehicles" and "Equipment".

In the Figs 1 and 2 the "basic functions" and "tasks" of the operational sector "Operation" are represented respectively. Furthermore, all necessary input and output data for each task was collected and structured (Fig 3) and described according to its designation, origin, destination and individual character (Fig 4).

On the basis of the results of the structure analyses and the derived weaknesses and with a foundation of the extracted basic function and task structures, necessary data and information requirements and optimal data and information flow, suitable system components were defined.

There are 15 system components in the operational sector "Vehicles" and 13 system components in the operational sector "Operation" (Fig 5).

These system components, for which all input and output data has been determined represent the concept for the development of a standardized, modular, component-based operation control and information system for the public transit sector.

Systems already under development (shaded in Fig 5) must be integrated into the overall concept.

OPERATIONS CONTROL AND INFORMATION SYSTEM by: H. Kaufhold

The next phase of the project is to produce system specifications containing uniform terms of reference for the system components, for producing standardized software and for setting up a standard data structure. The analyses of data requirement and information flow already carried out, have shown that a large number of tasks fall back on the same basic data, which means that data once stored, can be repeatedly polled and processed. Development of a suitable data structure or data bank from which data can be polled for all components is, therefore, the most important immediate task of further development.

Furthermore it is intended to carry on a component-by-component development of the operations control and information system in close cooperation with interested transport companies starting with: System specifications and going on through programming, function testing, system testing, integration testing and introduction of the system.

A work group has already started work on development of the first components.

Proceeding in this way brings the following advantages for the development, financing and introduction of new systems:

Development and cost risks are minimized for the individual companies, expensive parallel development is avoided and therefore available capital can be efficiently invested and it is possible to introduce new systems, expecially into small and medium-sized companies at short notice.

Reference:

SNV Studiengesellschaft Nahverkehr mbH
"Betriebsführungstechnologien ÖPNV"
(Operational management technology in the public transit sector)

- Final report -

Commissioned by the Federal Minister for Research and Development.

2000 Hamburg 20;
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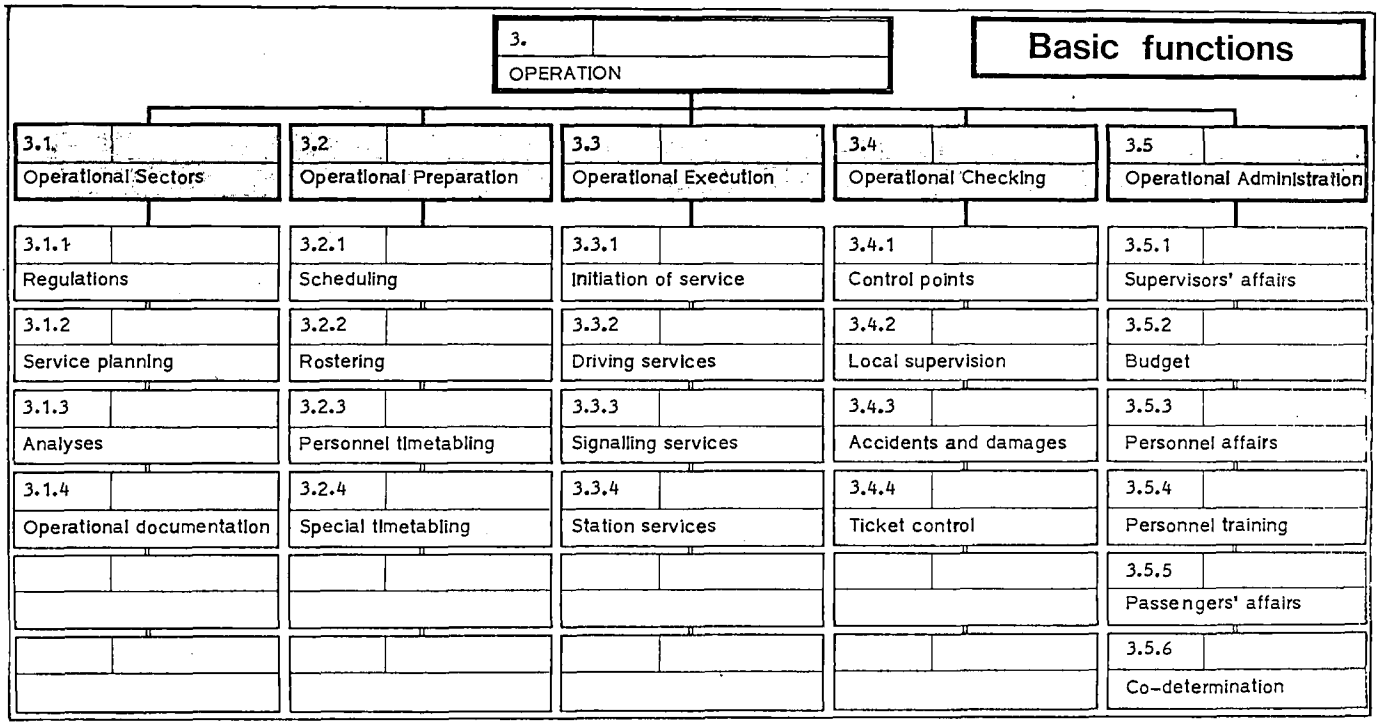

Fig. 1: Structure of the basic functions in the "operations" sector

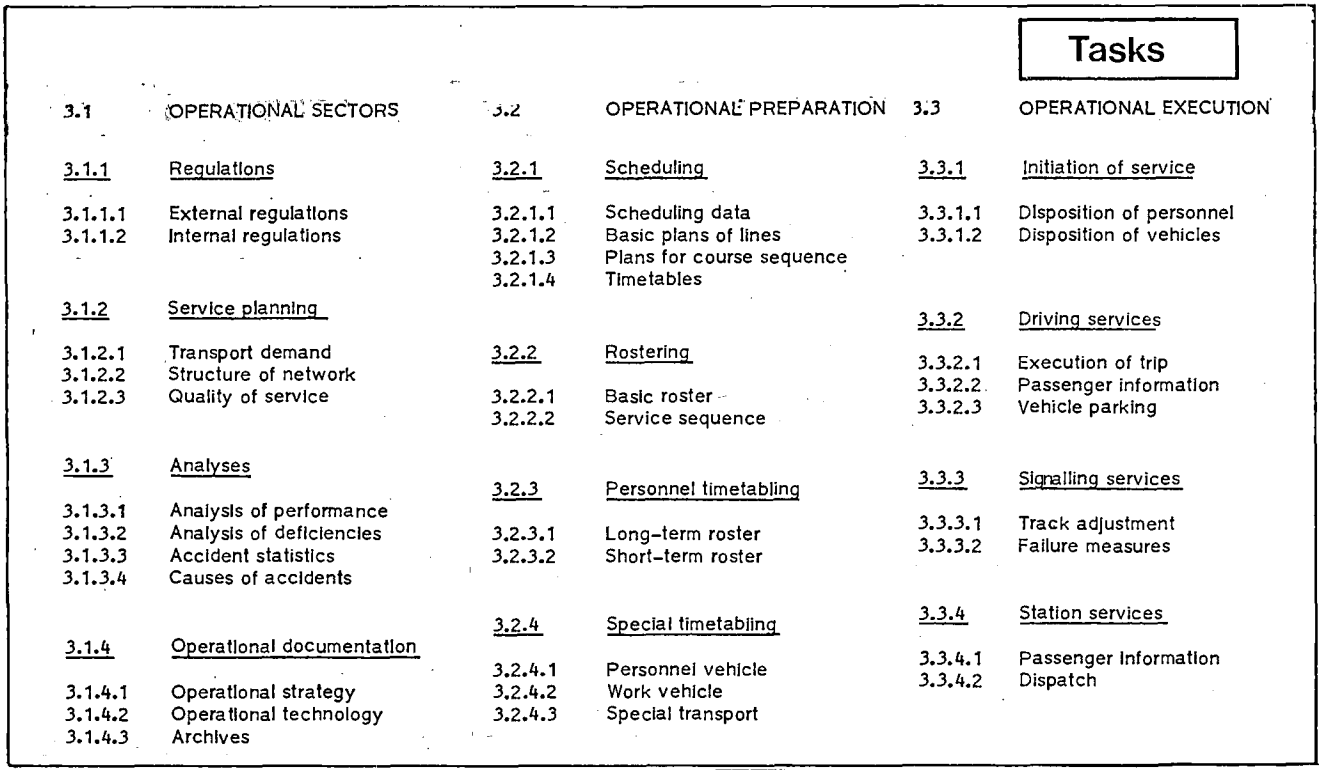

Fig. 2a: Structure of tasks in the "operations" sector

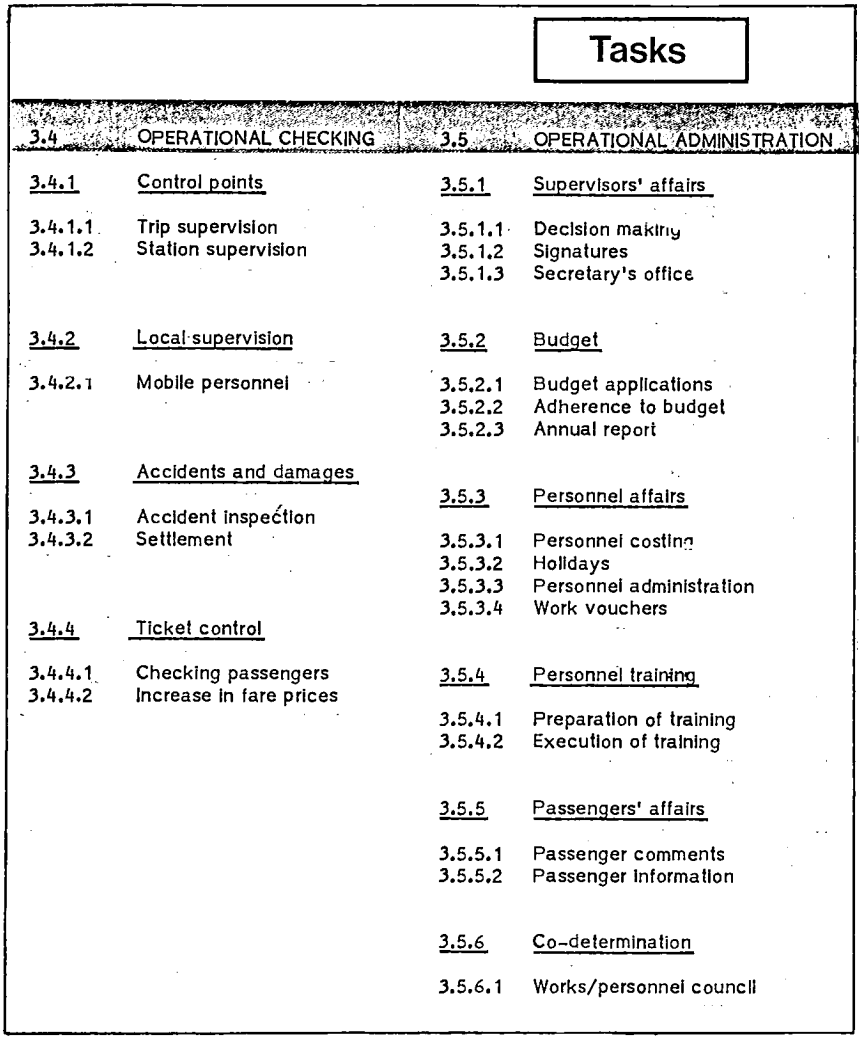

Fig. 2b: Structure of tasks in the "operations" sector

INCOMING DATA for 3.2.3.2/1			Task: Short-term roster Sub-task: Reserve duty disposition
From task:	Data bearer	Data contents	Single data
3.1.3.1/2	Timetable 03 F 72	Line by line data of despatch time from each station	* Timetable
3.2.2.1/2	Roster (1) 03 D 02	Data about deployment times and locations of employees without their designation	* Roster (1)
3.2.4.2/1	Works train voucher 03 A 04	Timetable for works train	* Works train voucher
3.2.4.2/2	Safety instructions (1) 03 S 09	Structured tasks for the safety of working locations	* Safety instructions (construction)
3.2.4.3/1	Special timetable (1) 03 S 07	Data about the deployment of extra vehicles	* Special timetable (1)
3.5.1.1/1	Special transport intructions (2) 03 S 14	Data for operating personnel about measures to ensure safe and correct regulation od special transport	* Special transport instructions (2)
3.5.1.1/2	Rotation of duty (2) 03 D 08	Data about the fixed sequence of duty	* Rotation of duty (2)

Fig. 3: Incoming data for sub-task "Reserve duty dispositon"

From task:	DATA FLOW DEFINITION	Letter: D
3.2.2.1/2	Roster (1)	Code: 03 D 02
To task:	**Data contents**	**Single data**
3.1.3.1/1 3.1.3.1/2 3.2.2.2/1 3.2.3.1/1 3.2.3.2/1 3.2.4.1/1 3.5.1.2/1 3.5.6.1/1	Data about deployment times and locations of employees without their designation.	* Roster (1) - Schedule period - Branch of operation - Type of personnel - Day group - Duty group - Duty number - Job - Duty location - On duty - Off duty - Work time - Length of duty shift

Fig. 4: Data flow definition "Roster"

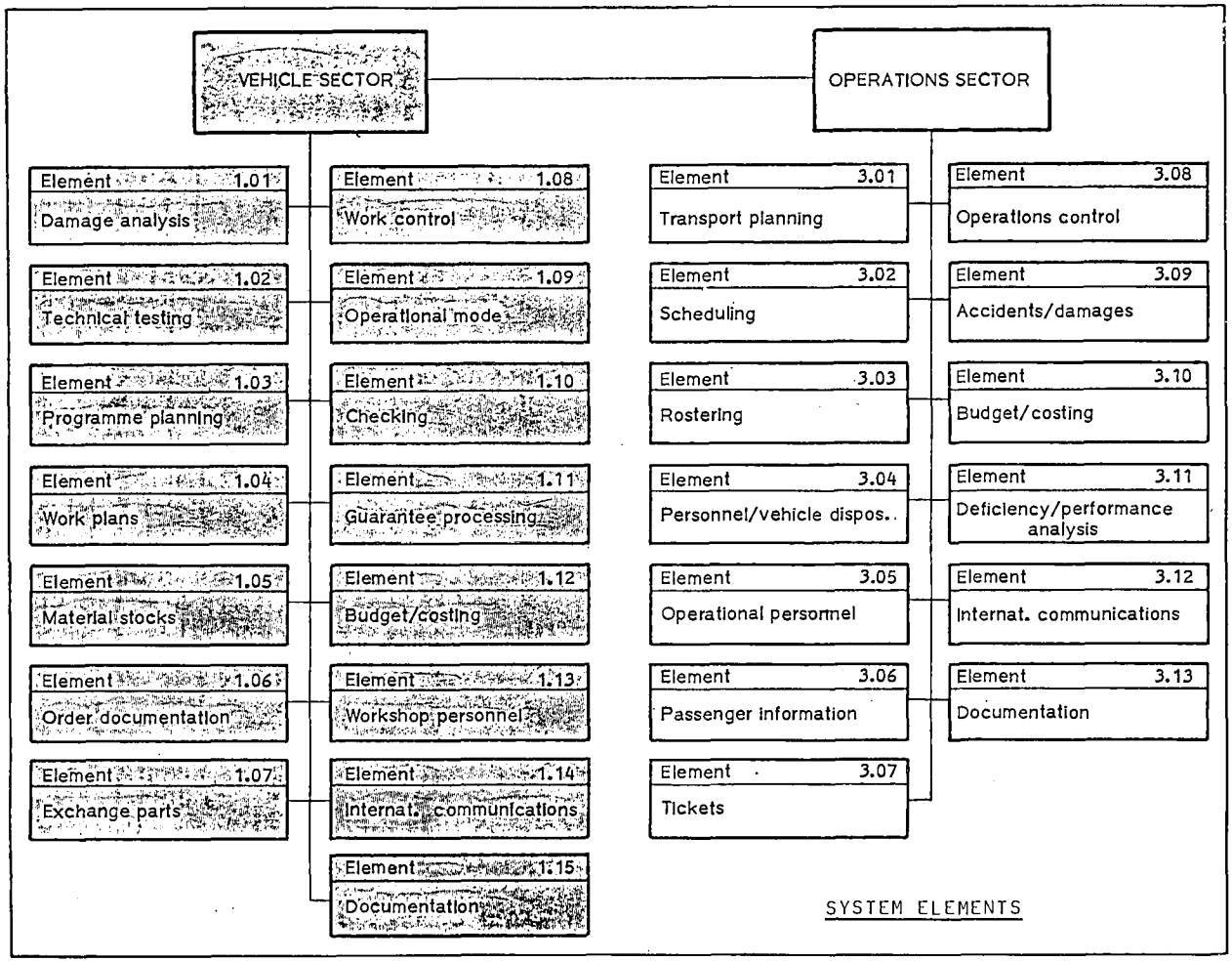

Fig. 5: Compilation of system elements for the sectors "Vehicles" and "Operations"