WCTRS SIG C2 „Urban Transport Operations“
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Quality Management for Traffic Signals

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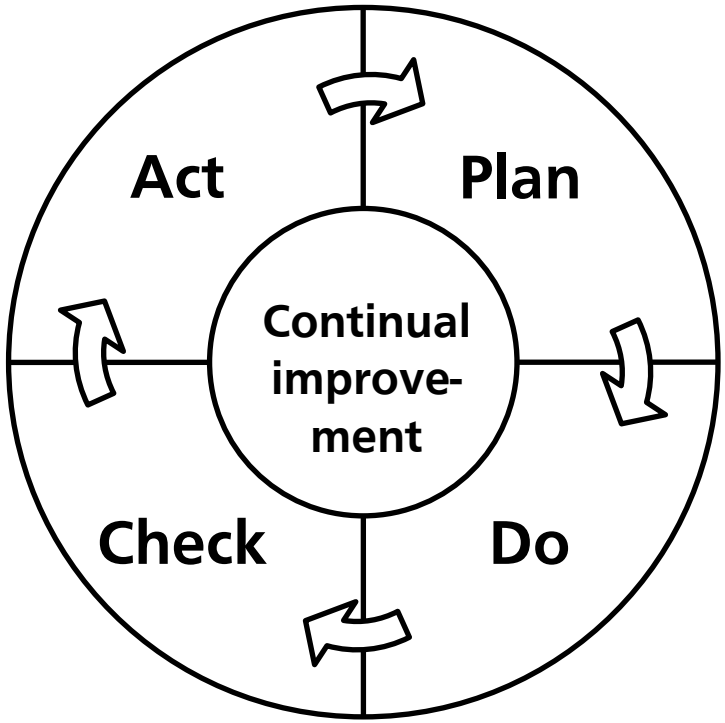

Need for Quality Management (QM)

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Traditionally, road traffic is not shaped by market-oriented supplier-customer-relationships.

Many approaches for quality ensurance already exist: guidelines, norms, safety audits, ...

So far, the efforts to reach a high quality are marked by

- isolated approaches and reaktion on pressing deficiencies,
- intuition and individual knowledge,
- limitation of available ressources, and
- limitation by available methods and procedures.

Need for action:
Integration into a comprehensive systematical approach for quality management.

Terms and Objectives of Quality Management

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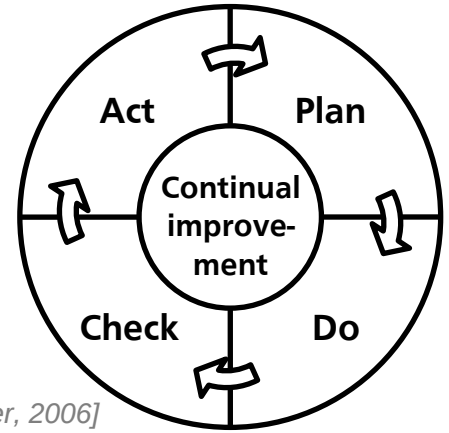
Quality: „Degree to which a set of inherent characteristics fulfils requirements" *[ISO 9000]*

Quality management: "Coordinated activities to direct and control […] with regard to quality" *[ISO 9000]*

QM aims for customer satisfaction and **efficiency**.

Quality management refers to **products** and **processes**.



[Kamiske/Brauer, 2006]

Product-related objectives of QM:

= traffic-related objectives (customer´s perspective)

- to ensure and to improve quality of traffic systems:
  → traffic safety
  → quality of traffic flow
  → environmental quality ...
- to ensure the customer satisfaction.
- to make quality provable.

Process-related objectives of QM:

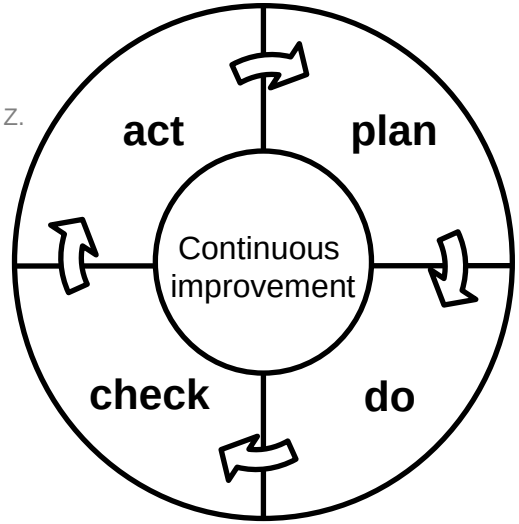
= operational objectives (operator´s perspective)

- technically correct, easy to maintain, flexible and robust transport systems.
- efficient processes and efficient use of resources.

Continuous Improvement (PDCA cycle)

PDCA cycle

Source: Kamiske/Brauer: Qualitätsmanagement von A bis Z. München/Wien, 2006



Quality management elements according to DIN EN ISO 9000 and the PDCA cycle with comparable content

Quality planning	⟺	Plan - P
Quality control	⟺	Do - D
Quality assurance	⟺	Check - C
Quality improvement	⟺	Act - A

Assignment of quality management elements to the PDCA cycle

Source: Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQML).. FGSV 2014

Tasks within Quality Management

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- determining the **interested parties** and their needs and expectations,
- establishing a **quality policy** and **quality objectives**,
- specifying and applying **processes necessary to attain the quality objectives**,
- specifying and applying methods and processes **to measure, document and monitor the quality** of the processes and products,
- specifying and applying **processes to prevent nonconformities and to eliminate their causes**,
- establishing a **process for continual improvement of the quality management system**,
- determining **responsibilities** and providing the **resources** necessary to attain the quality objectives.

[ISO 9000]

Products in Traffic and Transport

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Product categories acc. to DIN EN ISO 9004:

- **Hardware**
  - Network design
  - Roads/paths
  - Transport facilities including traffic signals
  - Drainage
  - Vegetation
  - Pavement
  - Road furniture
- **Software**
  - Transport concepts
  - Operational concepts, e.g. signal programs
  - Supply management
  - Demand management
- **Services**
  - Traffic information
  - Road maintainance…

Quality attributes

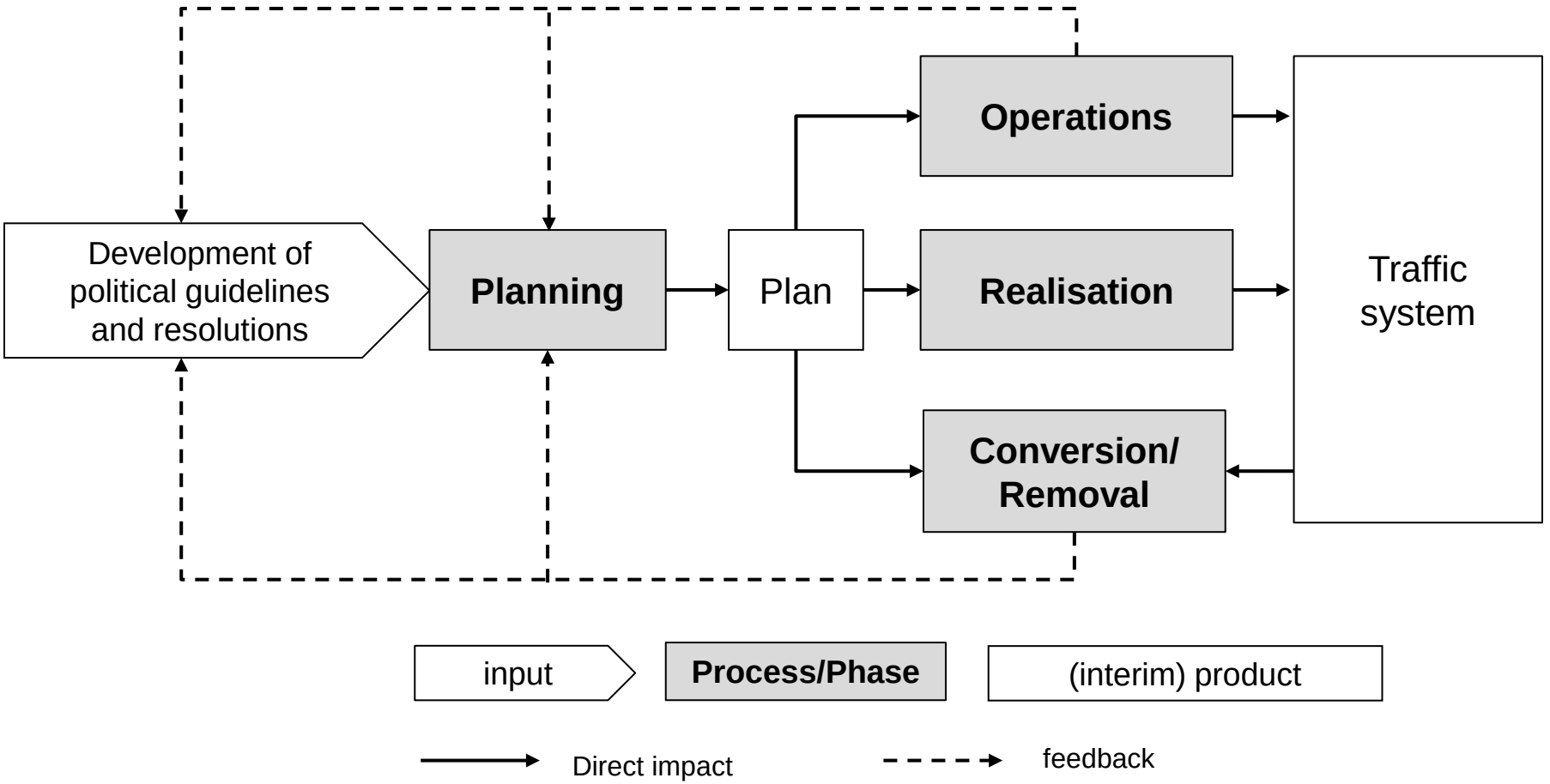
system-related:

- presence
- functional design
- system integration
- availability

traffic-related:

- traffic flow
- accidents
- emissions

Processes in Traffic and Transport



Matrix Structure to Derive QM Basic Modules

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Product categories according ISO 9004

products (transporation system)			processes							
			planning			realization	operation			
			master planning	development planning	detailed planning		basic operation	maintenance	traffic manamagement	observation
	„hardware"	streets								
		traffic signals								
		pt vehicles								
		...								
	„software"	traffic control								
		guidance								
		schedule								
		...								
	services	traffic info								
		schedule info								
		ticket distribution								
		...								

Source: BOLTZE/JENTSCH, Integrated Quality Management for Urban Transport Systems. Peer-reviewed article in: Selected proceedings of the World Conference on Transport Research (WCTR), Lissabon, Portugal, Juli 2010 .

Fachgebiet Verkehrsplanung und Verkehrstechnik

Basics (1)

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Systematic quality check and quality improvement

Entity of planning, design and operation:

QM is directed at

- intersection design
- traffic control
- technical components of traffic signals
- planning-related and strategical constraints …

QM in each phase: project design ... implementation ... operation

Close connections with other procedures ensuring quality
(e.g. safety audit on roads, local accident analysis, …)

➔ Coordinate procedures in a sensible way

➔ Use common data and results

Source: Chapter „Qualitätsmanagement“ (Quality Management)“ in RiLSA - Richtlinien für Lichtsignalanlagen (German Standard for Traffic Signals), FGSV 2010

Basics (2)

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Goals of QM for traffic signals

high traffic safety
good traffic flow
high reliability
good environmental compatibility

Added in HQML 2014
Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQML). FGSV 2014

QM should ensure that ...

…the planning-related and strategic defaults from the superior traffic planning and the conception of traffic management are still valid or adapted to changes,

…changing requirements are taken into account, and

…all the components of the traffic signals are ready-to-operate and work flawlessly.

Requirements on the traffic signal control

- easy to maintain
- flexible
- robust

Source: Chapter „Qualitätsmanagement“ (Quality Management)“ in RiLSA - Richtlinien für Lichtsignalanlagen (German Standard for Traffic Signals), FGSV 2010

Definition of parameters and assessment procedures

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Traffic flow parameters

- delay, number of stops, queue length, saturation, …
- additionally derivable: travel times in network, fuel consumption, noise emissions
- parameters for air pollution (partly derivable)

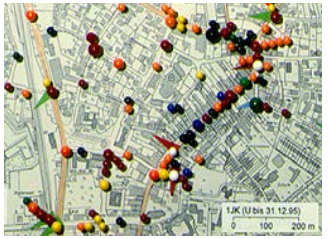
Traffic safety parameters

- accident costs / cost rate
- accident frequency / accident density …

Availability parameters

- disruption / breakdown frequency
- disruption duration …

… and others



Source: Chapter „Qualitätsmanagement“ (Quality Management)“ in RiLSA - Richtlinien für Lichtsignalanlagen (German Standard for Traffic Signals). FGSV 2010

QM in Traffic Engineering Project Design (1)

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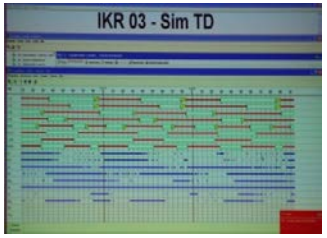
... professional and comprehensive

... clearly described and explained



Specifications at least for the following items:

- network function of the traffic signal
- local conditions such as maximum queue length
- control goals
- control method
- components of the signal program

  phase organisation, phase sequence, cycle time, green times; for traffic-adaptive control additionally the control logic with relevant parameters or automatic process data

Source: Chapter „Qualitätsmanagement“ (Quality Management)“ in RiLSA - Richtlinien für Lichtsignalanlagen (German Standard for Traffic Signals), FGSV 2010

QM in Traffic Engineering Project Design (2)

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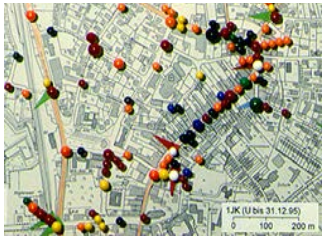
Documentation of traffic signals

- Goals and basic flow of the planned control and its components
- Management data (intersection name, short notation, control device type)
- Signal layout plan and signal group data
- Phase sequence plan
- Intergreen time calculation and matrix
- Signal programs
- Traffic-engineering description of the applied control method
- Used modules and automated method
- Activation and deactivation programs
- Test method
- Instructions for measures about disruptions of single data collection devices



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QM during Implementation

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Implementation of the control scheme (in form of **data or programs**), both in **initial implementation and later modifications**.

Testing before implementation.

Ensuring a continuous **consistency of data** in order to avoid quality losses.

Consideration of all **operational conditions** (activation, deactivation, behavior during any kind of disruptions).

The documentation of control must describe exactly, what is actually implemented in the device.

Source: Chapter „Qualitätsmanagement“ (Quality Management)“ in RiLSA - Richtlinien für Lichtsignalanlagen (German Standard for Traffic Signals), FGSV 2010

QM during Operation – Steps

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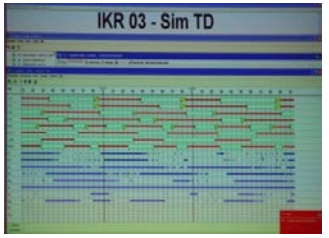
RiLSA 2010:

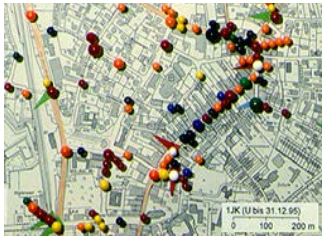
„If a permanent high quality has to be ensured for traffic control, a frequent monitoring during the operation of traffic signals is necessary.

Hence, it is recommended to carry out the following steps of quality management in a regular period and incident-related:

- check and adaptation of goals,
- check and evaluation of the achieved quality,
- identification of deficiencies and analysis of their causes,
- identification and implementation of improvement measures
- controlling the impacts.“

Complete documentation in all steps





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Fachgebiet Verkehrsplanung und Verkehrstechnik

QM during Operation – Information Sources and Frequency

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Information sources:

- basic information from planning documents as well as from the engineering description,
- accident data,
- process data from the control device
- operation and disruption data,
- information from experiences as well as inspections and observations at the intersection.

Frequency

For regular examinations, an interval of one year is aspired, whereas for some steps, longer time intervals may be sufficient.

Possible deviations from the scheduled interval in case of acute deficiencies, reconstructions or changes in network.

Computer-aided systems for data collection, analysis and documentation reduce the examination costs.

Source: Chapter „Qualitätsmanagement“ (Quality Management)“ in RiLSA - Richtlinien für Lichtsignalanlagen (German Standard for Traffic Signals). FGSV 2010

Stepwise Approach

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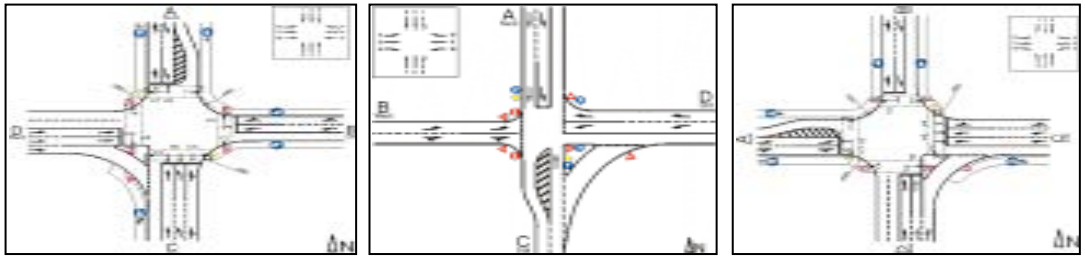
Network-based overall view

Quality analysis at single intersections



Identification of improvement measures

QM during Operation – Steps (0+1)

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0) Compilation of basic information

- Compilation of network-wide basic information (once)
- Compilation of traffic signal-related basic information (once)

1) Network-wide overall view

- Updating of basic information in case of relevant changes (yearly)
- Network-wide accident analysis (yearly)
- Network-wide assessment of traffic flow quality (yearly)
- Intensive assessment of traffic flow quality for parts of the network (as needed)
- Network-wide anaylsis of operational reliability (yearly)
- Network-wide check of environmental impacts (yearly)
- Selection of traffic signals to be checked (yearly)

Source: Forschungsgesellschaft für Straßen- und Verkehrswesen:
Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQML) 2014

QM during Operation – Steps (2)

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2) Quality Analysis for selected traffic signals (as needed according to results of step 1 and the targeted frequency)

- Actualisation of basic information in case of relevant changes
- Analysis of traffic safety
- Analysis of traffic flow based on traffic and process data
- Inspection of variable items of road design (e.g. in the context of road inspection) (periodically and as needed)
- Observation of traffic flow (periodically and as needed)

All tasks to be conducted periodically as well as in any situation when deficiencies are observed or obvious to come up.

Source: Forschungsgesellschaft für Straßen- und Verkehrswesen: Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQML) 2014

QM during Operation – Suggested Steps (3)

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3) Identification of measures for quality improvement
(based on the results of step 2)

- Analysis of causes of deficiency and compilation of possible improvement measures (as needed)
- Assessment of possible improvement measures (as needed)
- Selection of measures, implementation planning (as needed)

Activity spectrum

- Maintenance measures
- Parameter adjustments
- Structural changes in traffic control
- Hardware adjustments
- Constructional measures and changes in intersection design
- Changes in traffic plan-related and strategic boundary conditions

Source: Forschungsgesellschaft für Straßen- und Verkehrswesen:
Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQML) 2014

Proposed Issues to be Discussed

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State of development in Quality Management

- related to transport in general
- related to traffic signals

Degree of formalisation of quality management (recommended, enforced by law, certification, …)?

Acceptance of quality management concepts?

Efficiency / cost-benefit ratio in conducting quality management?