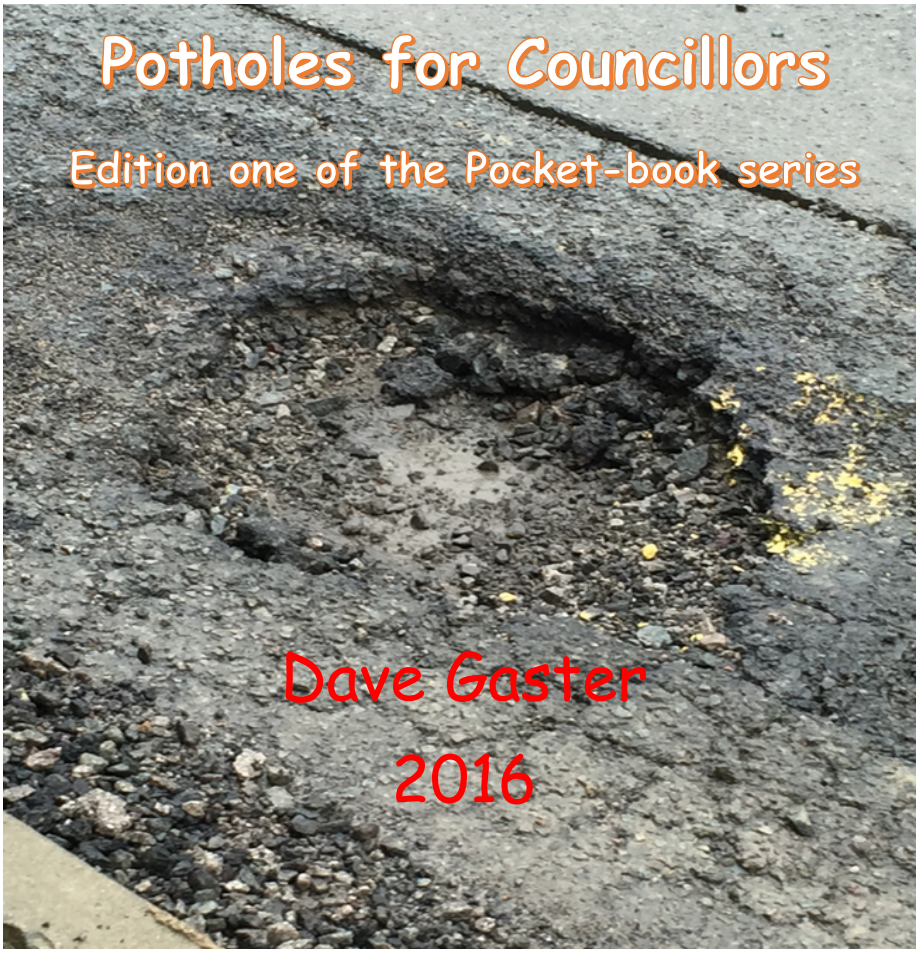

A practicable guide blending a professional awareness of highways with a light touch introduction to 'Lean and Systems Thinking' – Achieving More for Less.

Contents:

Pocket-book published by Support Services Direct as part of the Visualising Transformation series. Previous Books include: Visualising Transformation and VT-Achieving More for Less.

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1. Introduction:

The Councillor Pocket-book series are designed to be short, useful summaries for Local Government issues, without dumbing down the subjects, enabling Councillors to ask better questions.

Booklet one: Potholes:

While potholes are only the responsibility of Highways Authorities, they affect everyone who use carriageways (roads) and footways (paths). Thus potholes impact on all levels of Local Government, plus the NHS (due to accidents), the Police and the Highways Authority.

In some ways potholes is the ideal subject for this first pocket-book, as this should show that common myths are incorrect, and that everything is connected.

Real life Case Study:

A council was seeking to divert some monies into the pressured Social Care budget, so they diverted some money from highways, by cutting two highway inspector posts. Thus gaining £60,000 a year in Social Care.

In time; the quality of highways reduced, more defects occurred and in time more personal accidents happened.

Some accidents for the old and frail led to some injuries and a loss of confidence. This in turn led to greater needs for 'Care in the Community' with more people staying in their homes, with carers attending several times a day, long term.

The social care cost was £600,000 a year extra, when the root causes were highway incidents, which also escalated.

2. **Facts, figures and Myths:**

The UK has around a £13B backlog[1] of pothole repairs, which has increased by around £1B annually for some-while. These have become an increasing Political problem, made publicly tolerable due to awareness's of "Austerity"

It's quite clear that the term 'Potholes' means many things to many people: Most see broken up carriageways with an array of defects and call them Pot holes, while Section 58 of the Highways Act will guide inspectors to look for something that has a 19 mm high lip to it or 38mm dip.

Folk Law states: "most Potholes form because of ice in the cracks in the carriageway surface", that's simply not true. If the road were properly built, changed and maintained, there would be no cracks within the first 25-40 years.

Potholes form due to highway failures, the root causes of failure are influenced by:

- ✓ ***Design***: Including assumptions at that time.
- ✓ ***Construction***: Using the right materials, at the right thicknesses, compacted in the right way, in the right weather conditions.
- ✓ ***Changes***: Traffic volumes and weights, surface features including white lines, rumble strips and roundabouts, being dug up and repaired.
- ✓ ***Deterioration*** over time: Sun, Cold and Water all reduce the strength of a structure over time. (Over 40+ years)

[1] Based on Local Government Association January 2016.

3. **Costs:**

There are many costs either due to potholes existing, or to prevent them being a liability. Virtually every reported national costs of accidents I've seen in the papers shows the costs of vehicle repairs.

These are often just the cost of a punctured tyre, or broken suspension, with an average cost per claim of £250.

If 'Better Questions' were asked, you'd also discover the personal injuries, many amounting to a few hundred pounds, but quite frequent £10,000 plus, all the way up to £1/4M.

The costs of S.58 claims (Highways trips and falls) can often be £600,000 a year in each authority, hidden from the highways budget as they sit within insurances.

The costs due to potholes (and preventing defects causing claims) will include:

- **Highway Inspections**: These should be at least once a year, for every highway across the authority, with higher used highways being quarterly, and main shopping centre and school entrances being checked monthly.
- **Complaints:** Call centre, back-office, ICT, highways inspectors/ management, insurance team, assessors, legal+
- **Repairs:** Inspect, moderate, requisition, contractor, repair, invoice, inspect, pay….
- **Plus:** Highways condition surveys, NRSWA/TMA[2], general management and maintenance.

[2] New Roads and Street-Works Act or Traffic Management Act, are designed to control the ability for Gas, Electric ++ services digging up the roads. Note, the TMA is more useful to manage costs. See Prevention Chapter.

4. **Causes**

In a mature town, around 55% of Potholes form because the road had been previously dug up. Without those trenches: it's probable that those roads would be OK.

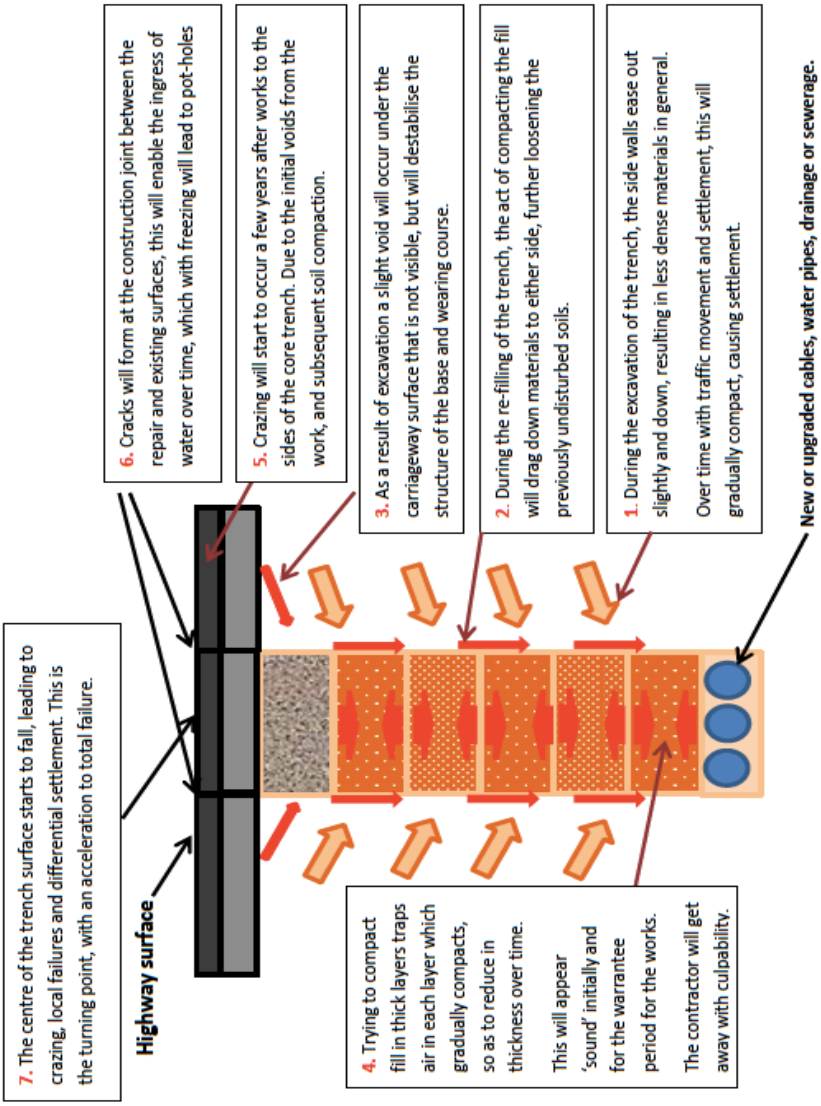

Figure 1. Cross section of a trench leading to failure.

There are 200+ reasons why potholes form, to become major problems. The cause and effect chart (C&E) below shows financial & operational linkages Fig 9 shows issues.

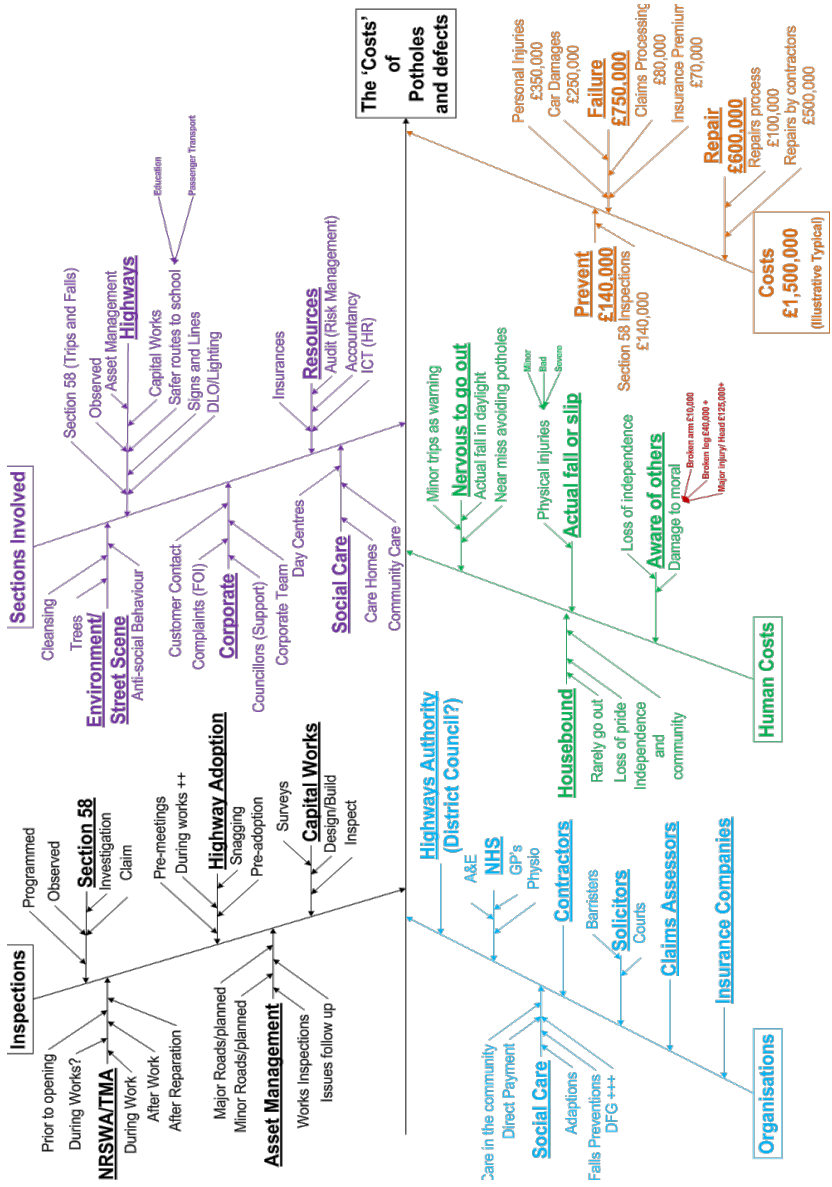

Figure 2. Cause and Effect Chart for Pothole costs.

The C&E chart is based on a method to collect many ideas quickly, then divide them up into manageable elements to address those issues. The chart shown was from an introductory workshop aimed at fast-tracking resolutions. That authority went on to halving the amount of potholes, generally repairing them when half the size.

Councils generally have two ways to repair Potholed roads, either patch each hole one at a time or carry out a wide area repair. Many patch repairs fail after a short while, and need repairing again, larger repairs are relatively expensive.

There are other ways, that not only deal with the immediate aspect, but also create a permanent hard wearing repair.

Figure 3. Picture of proprietary seam repair system.

This kit effectively toasts the surface causing the asphalt to melt, some additional materials are added to fill the gap, its then compacted with a grit layer surface for traction. This can be the ideal approach to linear failures, such as on

construction joints and over trenches.

In rural areas most potholes form due to either the edges of the carriageway failing or due to tracking, where repetitive loading over a narrow width causes failure.

It's generally impossible to resolve all problems immediately, the more 'Governance' within the system to control work, the greater the risk of significant personal injury claims[3].

Thus work needs to be assessed and ranked: Is it a legal trip? Will it get worse quicker? May it cause accidents or injury? Has it failed before? +++

Ranking is relatively easy via a Pareto Analysis, where 20% of the work may help save 80% of the costs. Take care to ask the right questions, as these charts display. Addressing most issues isn't the same as costs.

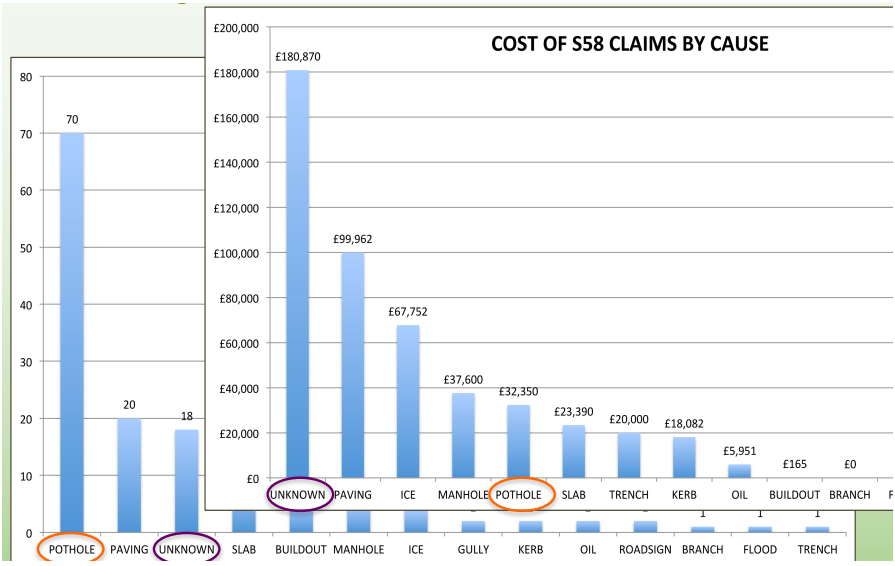

Figure 4. Pareto charts for S.58 claims volume & costs.

[3] See later Prevention Chapter

5. **Prevention**

Preventing potholes and highway defects is far easier than it may seem. Effectively there are many ways to stop the root causes of failure:

A. Design and construct highways professionally
B. Ensure all highways to be adopted are fit for purpose
C. Ensure all changes to those highways are sound.

A. Highway **designs** can often be less than optimal, by: under-estimating future traffic flows, not considering extra loadings at roundabouts/ cross roads, reducing kerb heights.

If a highway fails at a junction, it costs more to repair, so why under-design them? A 125 to 150mm kerb face helps prevent traffic parking on the footway, reduce that height, then path-parking will happen, then that footway will fail.

B. **Construction** has a wonderful array of wrongness- Too: thin, wet, cold, not compacted enough, wrong materials…

Have you seen massive clouds of steam when HRA is being laid in rain? Ten years later that length will be failing when the rest is fine. A contractor avoiding tipping good material which won't show; or wrong-headed contract designs?

UK infrastructure is experiencing significant investment and expansion, with many housing estates being built. Those developers are interested a) in selling houses, b) making a profit, c) creating an estate with 'kerb appeal'. Building the roads are merely a necessity to achieve a to c.

Those roads are built in sections, about 50 to 70m length at a time, invariably built up to 'base course' with the final wearing course added after all construction.

The construction MUST comply with specifications designed to enable an adoption of highways that will create no demands on the council for 25 years. I've NEVER seen that be the case.

They are built too thin, too wet, too dry, under-compacted, without awareness of the impacts of flexible constructions between rigid ones. Every estate being built now will be a £ burden to the council in a few years-time! ***Why?*** Because you ***can't afford*** a clerk of works to manage the construction!

Forward Planning? I've lived in three new houses on the edge of town for the last 30 years. In every place the edge of town has moved out further, and on every occasion new: Power, Drainage, Gas, Water and Services have been needed, leading to every provider to dig up newly built roads, totally wrecking them within years of being built.

If a forward plan was made sensibly, the size of pipes and cables would be adequate initially for the expansion, vastly reducing costs, and significantly reducing damage!

C. Changes can be quite subtle, things that make a *road safer* can make it fail quicker, for instance: Rumble strips and lateral white lines are designed to shake the car, but equal and opposite forces means it greatly increases highway damage; Build outs to make chicanes slow traffic down, but then creates an area with twice the traffic with significant turning forces; cycle lanes on a flexible road (finished with asphalt) can cause tracking where all vehicles are in the same 'lanes', this causes the asphalt to flow and fail.

Digging up the highway is regulated either via the New Roads and Street Works Act (NRSWA) or the more recent

Traffic Management Act (TMA). In general; no one should dig up any part of the highway without permission.

Then the methods of dig, protect and reinstate should be professionally managed so as to ensure there is no damage or issues during the work, nor as a result of the work.

Figure 1. shows the damages caused by a trench, which invariably leads to failure, potholes and accidents. There are short term economic and environmental benefits from digging out the sub-base then later re-using those materials as fill. However, if those materials are not suitable or not compacted in these layers sufficiently, those trenches will fail considerably before ten years, or at least 15 years before they should, passing costs and issues to the council.

The ***TMA*** properly applied is self-funding, you can manage all excavations and reinstatements, and pass on the costs of failures back on the utilities. NRSWA not done well, allows contractors to dig up roads, place illegal traffic control and poorly reinstate. Your current day cost-cutting for control directly increases tomorrows pressures. It's relatively easy to make a surplus from the TMA, paying for NOW prevention, saving FUTURE issues.

Section 58 inspections serve two main purposes, they manage the need to repair to prevent accidents and claims. While having a robust inspection regime definitely prevents costly litigation.

Effectively every highway needs appropriate inspection[4] at least once a year, keeping a thorough record of defects,

[4] Appropriate is based on the highway type and usage, more often, more detailed for high footfall, high use highways.

raising orders to repair, where-ever a notifiable defect is present, or where a defect may deteriorate quickly.

These inspections can vary from 'course visual' from within a car as passenger on rural roads, to walked both sides of the road, once a month in town centres.

Asset Management inspections and awareness are a core aspect for managing the whole infrastructure which is worth billions in most authorities.

Inspections tend to be tri-annual ranging from very high detail machine and camera analysis, providing a thorough awareness of all assets and their condition, through walked fine visual, to 'driven' course visual.

The highway network: Carriageway, Footways, Verges and all assets (Street lighting, signs, lines, furniture) are individually assessed and recorded, with segments (Transects) of roads, say 10m long each being given a 1 to 5 or 1 to 10 ranking, from perfect to 'falling apart'.

Bringing all these 'Silo based' separate functions together[5] enables a sweet spot[6] to optimise future work plans, typically via the Local Transport Plan (LTP), against awareness of what to do in the short term.

Silos or Subject Matter Experts, are great for discrete pieces of work, but generally hopeless to manage complexity. Most often, processes are designed as if everything is the same, 'A pothole is a pothole'. Chapter 7 shows how complexity can be addressed using some common sense.

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[5] Collaboration across all parties can be difficult due to HR structural designs.

[6] See later chapter on 'Voice of the Asset'

6. **Seasonality**

The seasons impact highways in differing ways, for instance extreme cold spells will lead to more accidents and the surface break up of crazed pavements.

Surface dressing programmes are far more effective in the summer months, as these tend to give longer days, better curing temperatures and fewer weather issues.

Major reconstruction works are also better carried out from April to October, as more work can be achieved per day in longer drier days.

The LTP should be designed in such a way as to optimise all Designs and Approvals in advance, so the most cost effective work can happen at the right time, with all operational and tactical decisions in line.

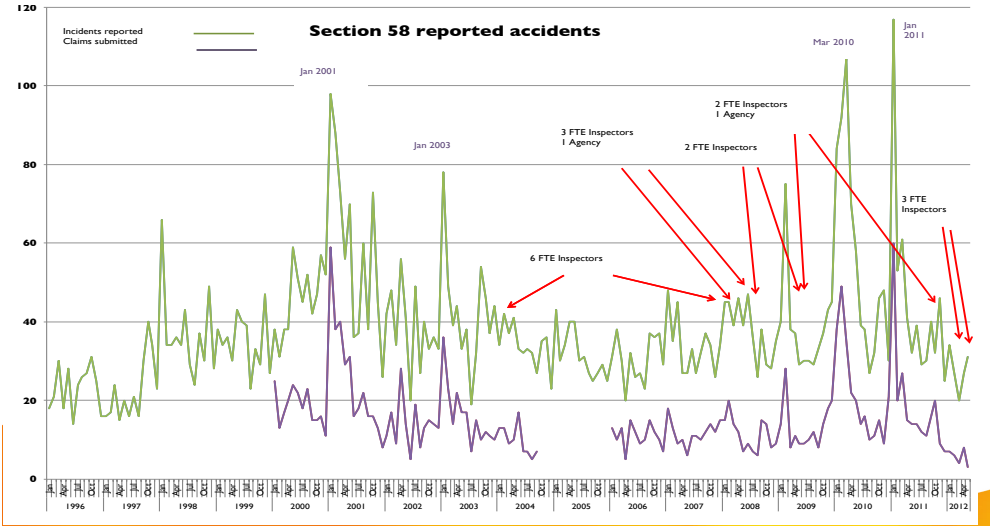


Figure 5. Record of monthly claims: Annotated run chart

NOTE: There were more claims made when there were fewer inspectors. The costs of claims were far higher.

7. Voice of the Asset (VotA)

VotA is not a 'normal' highways term, thus needs a little introduction. In the same way that many customer services functions listen to their customers, it makes a great deal of sense to listen to your highways asset, which is likely to be worth £Billions.

Chapter 5 shows that asset awareness surveys are carried out every three years for a deep awareness of the asset, plus at least annually to avoid potential trips and falls.

If all these records were recorded in maps, they could be examined and understood better, that's why we use Geographical Information Systems (GIS) to support this.

GIS could also be used to record the construction method for the carriageways, which in broad terms can be one of three types: a) Well-engineered Asphalt (HRA) or (DBM) based, b) Crushed stone with a thin asphalt surface, or c) Reinforced concrete (perhaps with an asphalt overlay).

System b) is used predominantly for Rural Roads and used to be common for urban estate roads. The design relies on the surface to keep water and surface pressures away from the stone below. Once it starts to fail, it deteriorates quickly.

One of the beauties of GIS is that you can combine information layers, as overlays, thus its relatively easy to look at all system b) construction areas against condition rankings of 9 and 10 (Very poor condition).

While this may amount to less than 3% of the asset, it may lead to over 55% of reported potholes. Thus VotA would suggest that its far more cost effective to treat those

reports as 'Urgent', to get them inspected and repaired immediately, as one timely repair may help prevent 18 other incidents in the next few days.

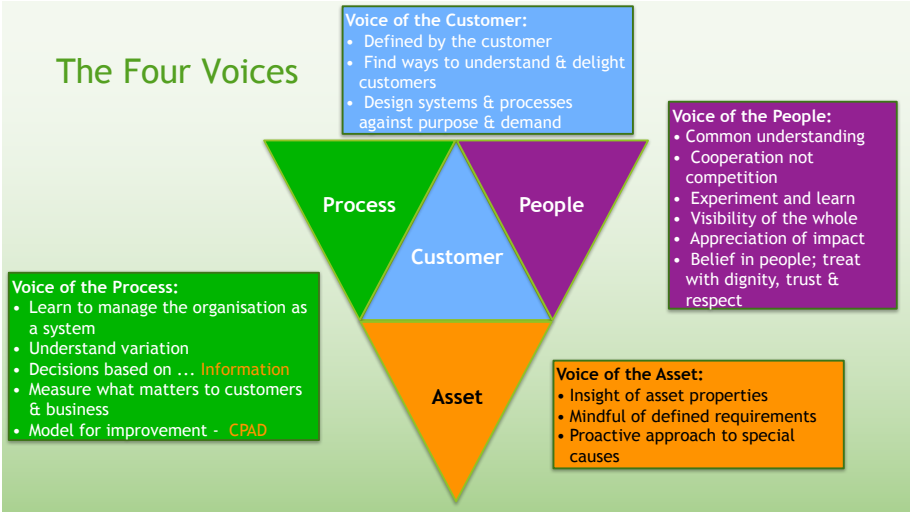


Figure 6. Voice of: Customer, People, Process and Asset.

If all processes are designed being fully informed by People, Customers and the Asset, then common sense will emerge.

Moving on from the >3% asset <55% issues aspect for roads, now let's add in some other common sense. Defects, hazards and risks arise due to all sorts of reasons across a highway network, including: Severe frosts, heavy rain, storm force winds, Road Traffic Collisions and Fires plus spillages.

Therefore, if the S.58 inspection regime had a little more capacity than the essential annual to monthly defensive inspection needs, those inspectors could add in:

- Carriageway checks in key locations after a frost,
- Look for lifting slabs near trees after a storm,
- Check for flooding after heavy rain,
- Look for sheet ice where it was wet…

Effectively they could work on their personal knowledge of their area, to head off bad defects, to prevent accidents.

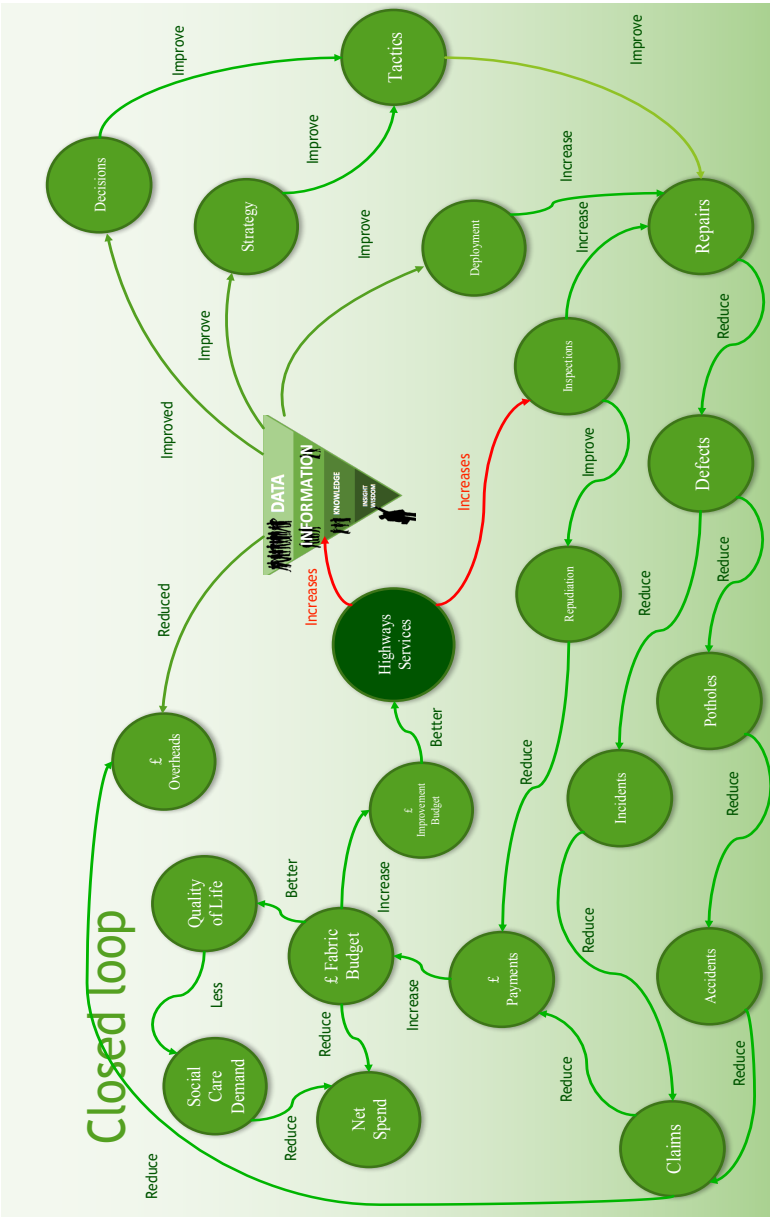


Figure 7. Spending a little more to save a £1,000,000

The closed loop diagram is based on real work that saved the council £1M a year, while adding £500K surplus to their TMA income. Achieved with no new ICT investment!

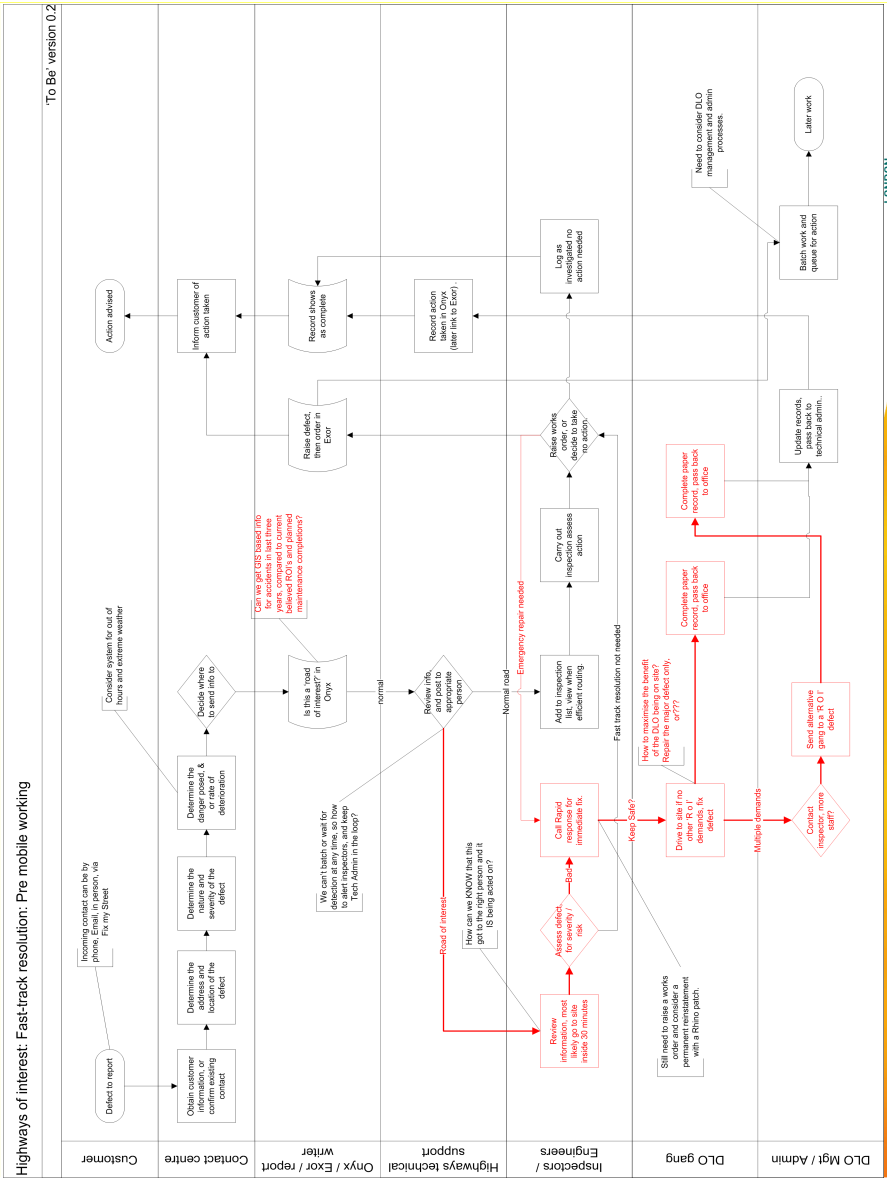


Figure 8. Highways of Interest: Fast track resolution.

It starts from two actions (red lines): Improving information (using GIS based filing system) and Increasing inspections. As a result of these, they virtually halved the number of potholes, often repairing them at half the size.

They were also allowed to go to reported defects, and repair a cluster of defects that surrounded it, simply taking geo-located photos before and after. Complaints reduced, issues reduced, claims reduced, monies were saved, while re-investing some savings into fabric improvements.

This simple flowchart shows how two processes co-exist. For 97%+ of the highways areas the black route was followed, when a report occurred in the 3% 'highways of interest', the red route automatically cut in, simply by linking the CRM to GIS, with position determining action.

The Cause and Effect chart that follows is divided into the tradition five headers of: Environment, People, Equipment, Process and Materials.

This chart was built within a highways review workshop in under an hour, simply by listing ideas on post-its, then assigning them to one of the five headings.

From there we devised better ways of working on high level flow charts, realising a great many changes to process were within the delegated responsibilities of the officers present, which in turn enabled some early quick wins, to make work easier and cheaper to do, addressing efficiency and effectiveness at the same time.

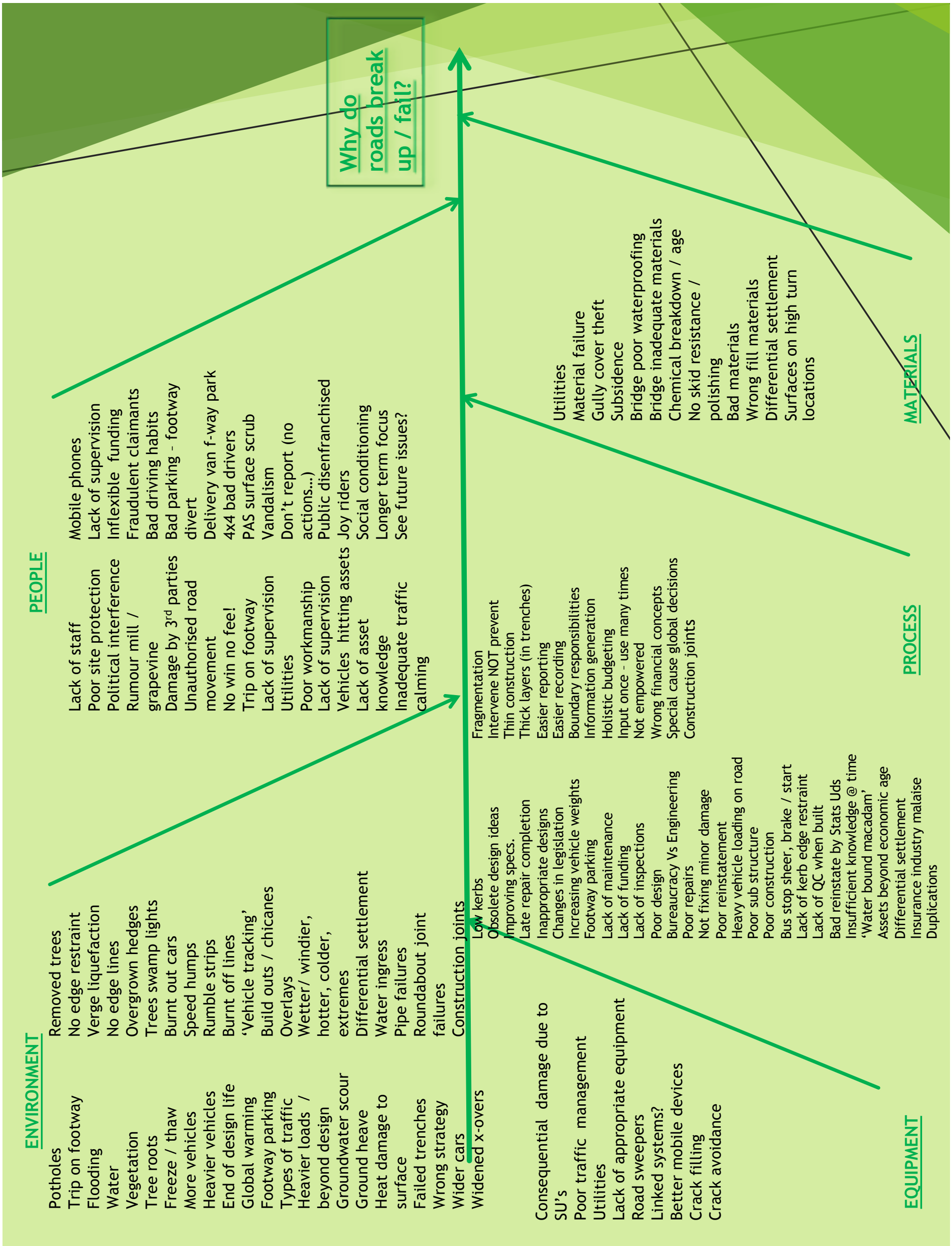


Figure 9. (C&E chart) Causes of potholes and defects.

8. **Cooperation and collaboration**

Highways management is a complex balancing act, where a few million a year is spent on something worth a billion plus.

Public sector principles make true partnering very difficult, even within a single authority, or just within the Highways function, before ICT, HR, Legal, Procurement, Audit and Scrutiny are involved.

Well-meaning controls can add to costs and even increase risks. For instance, in a council where trust had broken down, every repair needed a high level sign-off before being carried out. This led to two extra costs, for many defects they got bigger, and for a few defects several extra accidents occurred, including £10,000 plus injuries.

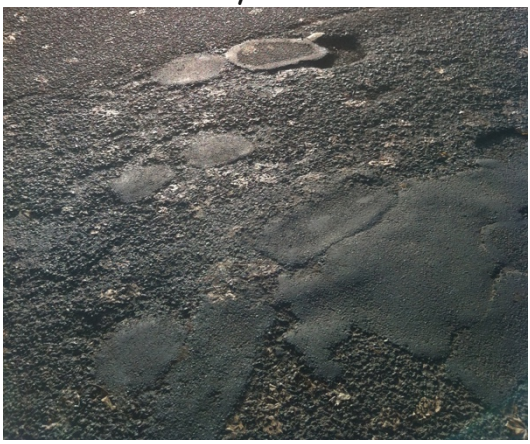
In the same council, audit required five separate documents to be filled in by repairs crews for every work instruction, by joined up discussions with audit, we reduced that to one, plus before and after pictures to carry out additional work not originally listed, some due to deterioration after these were first inspected.

Contractors generally are allowed to apply 'Lean' designs to their work, with no ability to influence the council. Often 2/3rds of their ability to add value is not allowed.

For a system to work well, it must be treated as totally joined up. Lots of efficient pieces, will never create an effective whole.

9. **Repair options:**

a) ***Repairing one patch at a time***: for 97% of the highways, this may be the right thing to do. However, normal cold rolled asphalt within a busy street will pluck out within days. Either use hot rolled asphalt (HRA) or proprietary high asphalt repair mixes. (This area was in a poorly constructed cul-de-sac, later made into a through road and then a bus route. The patches were over-lain for three years prior to resurfacing)



b) ***Patch repairing a failing trench***: virtually a waste of money, within weeks it will fail, as all the failing trench around it flexes with traffic movement. (This trench now has had patches applied to the patches and is falling apart quickly)

c) ***Patch repairing a busy junction***: often the turning forces are not designed for, so junctions fail earlier. If there is a weakness, many holes will form.

d) ***Patch repairing joints in HRA;*** once a joint starts to fail, that's a sure sign more will follow, the whole joint may need doing soon.

e) ***Patch repairing roundabout joints;*** a sure sign of under-design and poor construction. The whole joint will expose quickly.

f) ***Patch repairing around gulleys:*** Manholes and gulleys often have breakouts around them, as this is a rigid construction within a flexible carriageway (most often).

This is a 'special cause' failure, normal asphalt repairs will generally fail again, stronger methods will get nearer to permanent.

g) ***Patch repairing surface crazing***: this could be due to the construction during wet-weather laying eight years

ago. Within a relatively short time the whole area will need planing off and relaying. This is often seen on long dual-carriageways, have you ever wondered why it's fine for miles, then poor for about 50m?

h) ***Patch repairing a subsidence area:*** similar to a trench, once the lower layers fail, the rest will follow. Often happens between rigid constructions.

i) ***Multiple services:*** water meters will generally be fine when installed on their own, however as a cluster, they will have loose material in-between.

10. KPI's and PI's

Continual improvement needs some measures to help long term monitoring. It's often useful to think of a purpose for change as well. In this case the purpose could be: "To continually improve the condition of highways, to have fewer defects and issues, leading to happier customers".

Key Performance Indicators (KPI's):

Number of complaints a year

Cost of failures:

a) Vehicle claims
b) Personal claims

Backlog of repairs £ value

% carriageways in worst fabric condition (very bad)

Performance Indicators:

Annual cost of S. 58 insurance

Annual cost of claims assessors

Time from complain to acceptable report

Cost of S. 58 management

Value of TMA (NRSWA) fines

Defects % within highways changed in last ten years.

Defects % within adopted highways in last ten years.

11. **Asking better questions**

Have we the capacity to inspect to optimal S. 58 needs?

Are we utilising the Traffic Management Act well?

To ensure no utilities carry out unauthorised work

That no utilities set up unauthorised traffic management

That all works are to finished standards

How soon after adoption do we need to maintain estates?

Have we contractor surety rating awareness? (best- worse)

Do we use surety as an indicator of needed checking?

Do we have claims due to slow report to repair times?

Do we pay claims which we couldn't defend? (lack of proof)

Do some repairs keep being needed?

Are some claims clustered near similar previous ones?

Are social care incurring costs due to earlier trips and falls?

12. Some achievements via Lean and Systems Thinking

Processing S. 58 claims. A large county council had six local highway divisions, with variable outcomes for NRSWA and Trips and Falls. It needed to reduce costs across the whole Directorate by at least 15% within the year. A L&ST review was established to look at claims processing from receipt to finalising the investigation report.

The review found that there were dozens of highways officers involved, from management and administration through to highway inspectors. Completed incident reports would be compiled and sent to audit who managed the interface with claims assessors and the insurance company.

The majority of transactions were about progress chasing rather than doing productive work. The claims assessors would ask for additional information on over 40% of reports.

Following some training, redesigns and small scale trials a large trial was set up. This moved from over two dozen officers being involved in highways through to a full time inspector, an administrator and about 45% of a manager, mainly to ease access to certain records.

Costs reduced from £300K a year to £67K, while the average time from incident to completed report reduced from 90 days to 2.65. Report 'adequacy' improved from 60% to 100%. On-costs from audit and charges from assessors both reduced, successful repudiation of claims increased.

NRSWA enforcement: A metropolitan council had decentralised enforcement to areas, but was suffering with poor reinstatement for signs and lines for parking enforcement.

An agency NRSWA inspector was added to the establishment, sustained by earned enforcement income from defects. Income was about 60% greater than all costs, while parking income also increased.

Pothole and defects repairs. A London Borough needed to save at least £1/4M from its highways budget, they had their own DLO for minor repairs, but were greatly hindered by poor operating systems and complex governance.

They were able to link their highways database to their customer call centre CRM via their GIS. Utilising Crystal Reports they were able to link highway condition surveys to types of carriageway construction to see 'Roads of interest'.

They discovered that 55% of 'trips and falls' occurred in those 3% poor asset areas. Thus all issues on those areas were fast-tracked to avoid repetitive accidents and injuries.

DLO reporting was greatly improved from five paper reports to one, with permission to carry out 'needed' secondary repairs via before and after photographing.

Productivity increased, costs reduced, special pot-holes were often repaired in a few hours from reporting, holes reduced in both number and size. Incidents reduced, claims reduced. This was a major part of saving £1M per annum.

TMA Improvements. The same LB was making a £500K surplus on the TMA, but doubled this via Pareto analysis of worst offenders, Tactical core drilling, 'Self-funding' weekend working and map based deployments.