Visual management/visual controls implementation pilot : 5S in highways construction and maintenance

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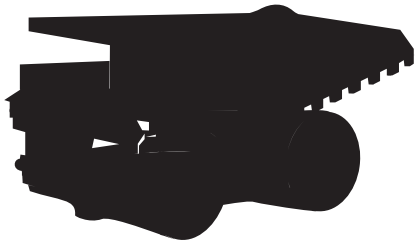
Executive Summary

This reports presents a collaborative research effort between the University of Salford and Highways England on the implementation of the Visual Management (VM) concept, a fundamental element of lean construction, in the highways construction supply chain. After 10 visits to 5 different highways construction sites to identify VM implementation opportunities for the project, the 5S, which is a systematic visual workplace structuring methodology and the very first step to creating a visually transparent workplace, was implemented in one of the highways construction sites. The recorded benefits include a significant reduction in item transaction times (circa 50% reduction on average), savings in space (both vertical and horizontal), and improvements in the overall health and safety conditions. Alongside demonstrating the captured benefits, the report also explores the current 5S condition and how to disseminate the 5S concept further through the highways supply chain. A discussion of the 5S pilot and the 5S in general as per Highways England's KPIs was also presented.



Introduction

The Visual Management/ visual controls pilot implementation project is a part of the research collaboration between the University of Salford and Highways England. Following on a preliminary report (Tezel and Aziz, 2015) on visual controls at the workface of highways schemes, this research project aims at documenting and discussing the benefits of a pilot Visual Management/visual controls project implemented in the highways supply chain. Visual Management (VM) is a fundamental concept in the lean production system and also, in lean construction practices. It is an information management strategy that relies on the effectiveness of sensory information integrated into process elements; close to where information needs might occur (Tezel et al., 2015). Three characteristics distinguish information displayed in VM from other forms of communication: (i) the information is presented in a self-service fashion to create information fields, (ii) the information is entirely determined ahead of time; and (iii) the information relies little or none on spoken words (Greif,1991; Suzaki, 1993). Its direct effect on processes is increased process transparency, which is the communication ability of process elements (Formoso et al., 2002).

According to Moser and Dos Santos (2003), increased process transparency induced by visual systems in construction leads to (i) simplification and greater coherence in decision making and production control, (ii) stimulation of informal contacts throughout different hierarchical levels, (iii) contribution to introduction of decentralization policies, (iv) broadened employee engagement and autonomy in management and (v) rapid comprehension and response to problems.

Construction sites, by their nature, present also specific barriers for increased process transparency; (i) they are constantly changing environments where a large number of crews move continuously; (ii) the site layout suffers several modifications throughout a project, demanding an intense effort to update and relocate the necessary set of visual devices; (iii) construction sites are relatively large places where different crews spread out; and (iv) non-removable visual barriers are incorporated into the working environment as the facility is being constructed (Formoso et al. 2002).

Before embarking on the project, 5 different highways construction sites in three different regions in England (Northwest, Yorkshire and Northeast) were visited for 10 times in total to identify the practical gaps and opportunities for the pilot (see Figure 1).

Fig. 1. Research team presenting VM and the 5S to management at one of the visited construction sites

The primary data collection methods of the visits were site observations and open- ended discussions with the site mangers and staff. The visits, which took place between May-July 2015, revealed a set of VM implementation options. Those options included:

1. *The 5S as a visual work place structuring/control effort;*
2. *Deployment of the A3 methodology for quality, safety and continuous improvement;*
3. *Developing collaborative meeting and continuous improvement boards for work teams;*
4. *A visual control board to connect the Collaborative Planning with site tasks.*

In coordination with Highways England, the research team was directed particularly to two construction sites located in Northwest England for the pilot implementation; Project 1 and Project 2. A complete set of the implementation options was presented to and discussed with the staff of those schemes (see Figure 2).

Fig. 2. Research team presenting the VM implementation options to project 2 management

However, Project 2 suffered personnel turnover and some unforeseen incidents between August-September 2015, which resulted in a significant slowdown in the research team's engagement with the scheme stakeholders. In the meantime, the staff at Project 1 agreed to initiate a 5S pilot in September 2015. Therefore, a 5S implementation pilot was decided as the way forward with Project 1.

2. The 5S

Being a fundamental lean concept, the 5S is a structured housekeeping methodology that is considered as the first step to creating a more transparent, visual workplace, with its many visual controls imposed on item transactions (Mastroianni and Abdelhamid, 2003; Galsworth, 2005; Kobayashi et al., 2008; Hodge et al., 2011). It also constitutes the basis for a visual workplace and many visual controls (Ortiz and Park, 2011) (see Figure 3).

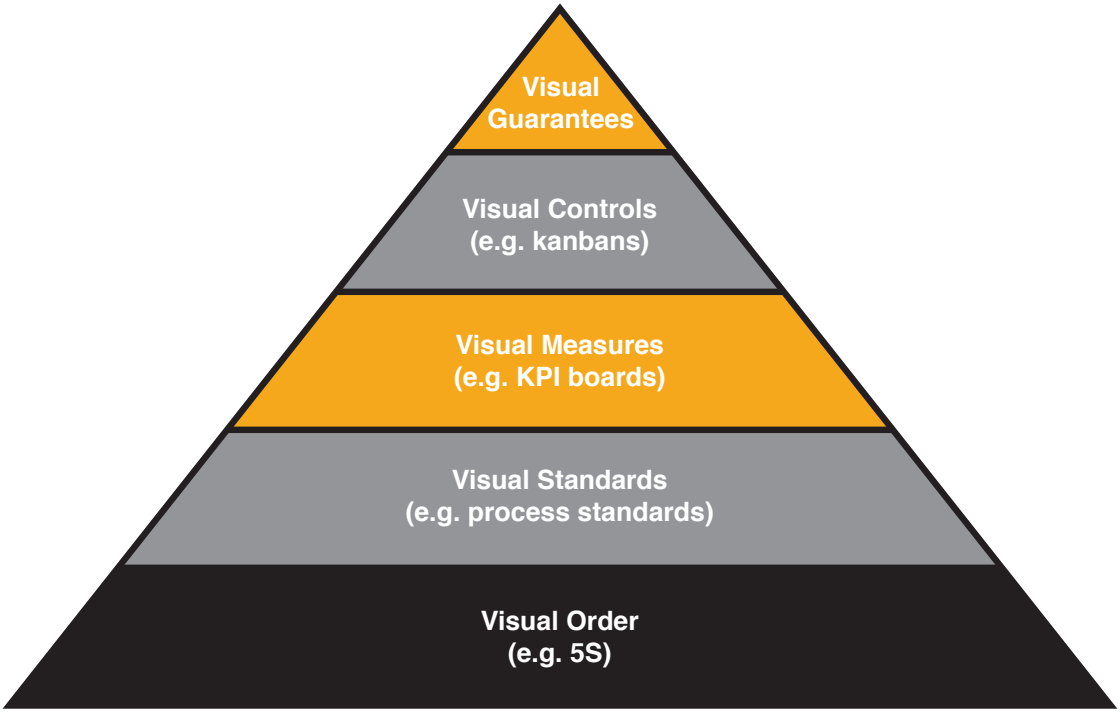
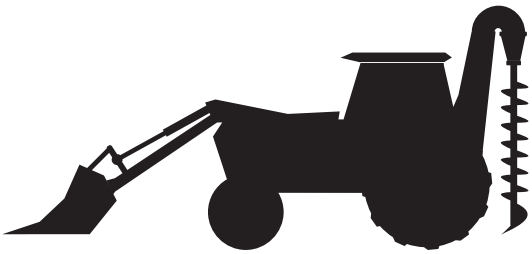


Fig. 3. Fundamental role of visual order and the 5S in creating a visual workplace

The 5S consists of the following steps in order (Osada, 1991; Hirano, 1995; Ho, 1999) (see Figure 8):



1. Sorting: Disposing of unnecessary items. The first step in rendering workplace cleaned up and organized. This improves efficiency, helps increase quality, and makes it simpler to spot problems and enhances productivity. Usually, sorting is realised by a red tagging strategy, which is adding red or coloured tags to various items (everything - materials, tools, equipment, consumables, processes, paperwork, computers, computer files & programs, processes etc.) that people think they might no longer need (see Figure 4).

Fig. 4. Red tag examples for the sorting in the 5S

2. Setting-in-order: Visually standardizing the necessary items with visual controls. Arranging the needed items so that they are readily accessible and labelled. Anyone can find them or put them away. It is the process of taking the required items that are remaining after the removal of clutter and arranging them in an efficient manner through the use of ergonomic principles and ensuring that every item “has a place and that everything is in its place” (see Figure 5). This step relies on using visual controls extensively. This step mainly addresses motion related (e.g. searching, asking, wondering, wandering, thinking, guessing) and item related (e.g. item loss, excessive items, insufficient items, items misplaced etc.) waste reduction in the 5S.

Fig. 5. 5S order in the back of a workshop van.

3. Shining: Systematic cleaning, maintenance and health and safety checking for space and equipment. Sweep and clean the work area. The key purpose is to keep everything in top condition so that when someone needs to use something, it is ready to be used in safe and reliable way. Cleaning a work area produces and opportunity to visually inspect equipment, tooling, materials and work conditions.

4. Standardizing: It is the process of ensuring that what have been done within the first three stages of the 5S become standardized; It is ensured that the workplace has common standards and ways of working. 5S efforts should be supported and encouraged through the organisation (see Figure 6).

Fig. 6. 5S recognition boards

5. Sustaining: ensuring that the company continue to continually improve using the previous stages of 5S, maintain housekeeping, and conduct audits and so forth (see Figure 7). The 5S should become part of the culture of the business and the responsibility of everyone in the organization.

Fig. 7. A 5S auditing board for the sustaining

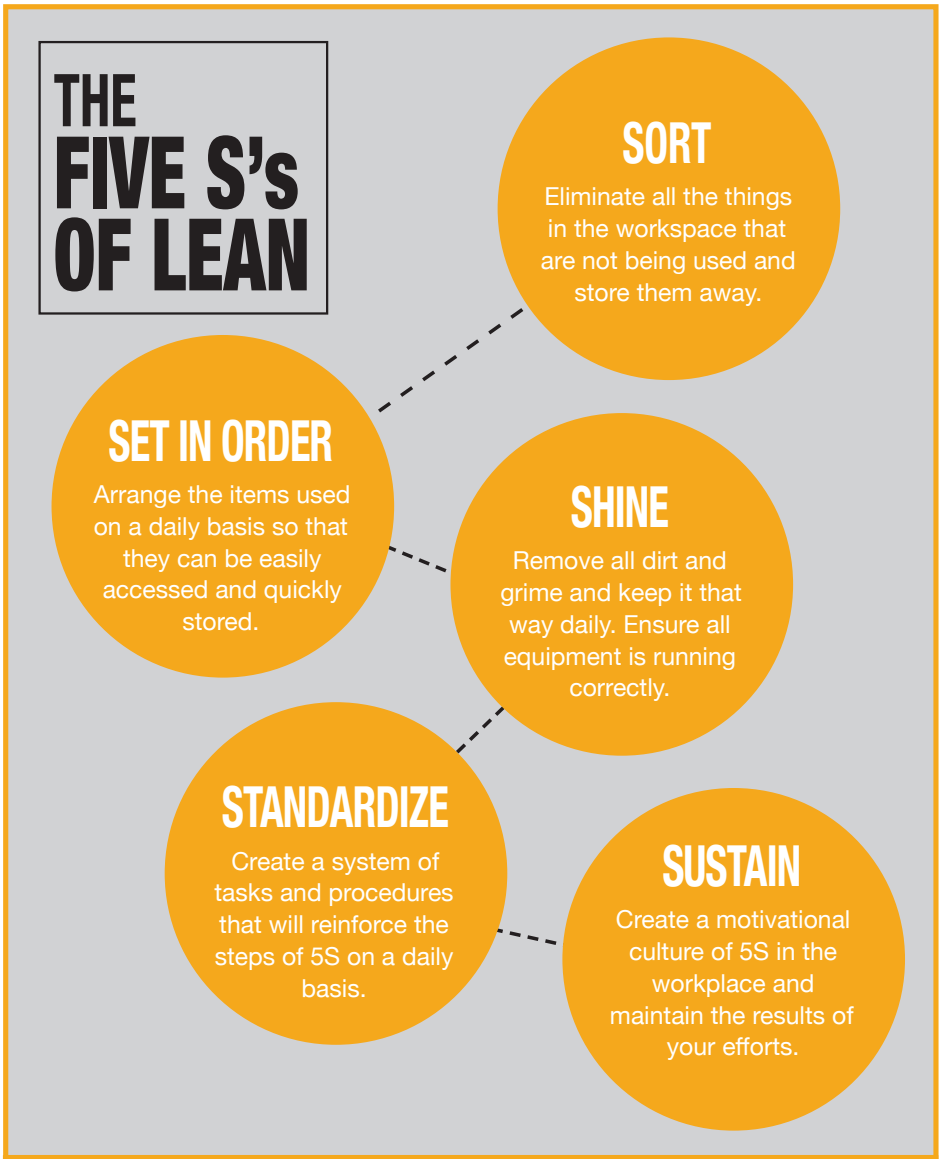


Fig. 8. Summary of the 5S

The main benefits of the 5S in a workplace are a decrease in the non-value adding activities (e.g. motion wastes, searching, thinking, guessing etc.) and excess inventory, alongside an increase in the usable workspace, overall health and safety condition and in ensuring machine/equipment reliability (Hirano, 1995; Galsworth 2005; Gapp et al., 2008; Ikuma and Nahmens, 2014; Jaca et al., 2014). See Figure 9 for the extended benefits of the 5S.

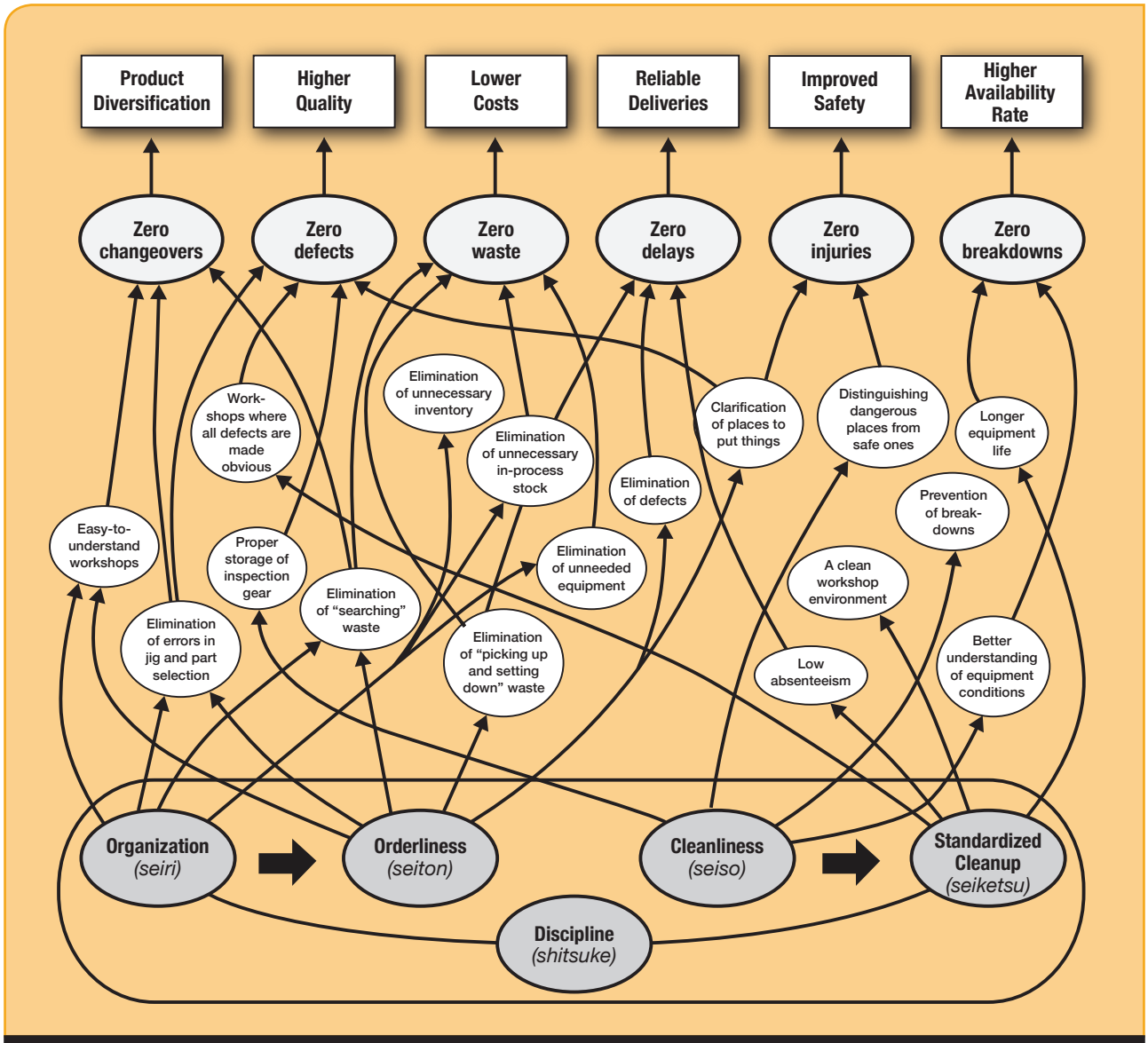


Fig. 9. Benefits of the 5S (Hirano, 1995:20)

Empirical studies on the 5S in construction are scarce. In an investigation on the penetration of lean construction among German contractors, Johansen and Walter (2007) determined that the 5S had been employed by only 16% of the contractors. Mastroianni and Abdelhamid (2003) reported a pilot implementation of the 5S in an industrial building construction project. According to the authors, the real challenge for the 5S for construction lies in sustaining a 5S effort. None of the 5 highways sites visited of Tier 1 contractors or joint ventures had a current 5S implementation effort. Due to its fundamental importance and yet, scarcity of its research in construction,

the 5S implementation pilot described in this report is important both from the practical and research point of view.

Some interesting observations as to the implementation of the 5S in highways construction and maintenance schemes have been made during the site visits;

- *As documented in Project 1, lack of ownership of the 5S results in unsuccessful 5S initiatives,*
- *In the supply chain, even within the same construction site, different service providers (Tier 1s and Tier 2s) have varying level of visual workplace order. The level of standardization in visual workplace order is low (see Figure 10)*

Fig. 10. Different visual order levels within the same construction site

- *The senior management at the service providers in the supply chain may think that the 5S is nothing more than good housekeeping. For instance, one of the process improvement managers at the visited sites had intended to initiate a 5S effort, but he was struggling in convincing his senior management on the benefits of the 5S. Ironically, the manager had already formed a 5S board for the failed 5S effort, even though there was no real 5S implementation within the construction site (see Figure 11),*

Fig. 11. 5S board on a site that was actually not implementing the 5S

- *The lean improvement managers of the visited sites struggle in explaining to their staff that specific lean construction concepts, such as the 5S, are not just for the manufacturing industry,*
- *Better training covering also more operational staff in the supply chain as to what the 5S actually is seems necessary,*
- *Highways England's lead and impetus are essential drivers for the lean construction related efforts in the supply chain. It makes a difference for the service providers, when Highways England clearly underlines and communicates the importance of a lean concept.*

3. The 5S Pilot and Its Benefits

A 5S pilot project was implemented at the storehouse within a warehouse of Project 1. The regularly supplied equipment (i.e. safety items), materials and hand tools are stored in the storehouse with an average daily cumulative of 42 transactions. These transactions occur between the storehouse personnel and the site personnel (process map).

In line with the scheme's lean construction and better housekeeping vision, the management had previously intended to implement the 5S for a while. However, due to lack of ownership, the management had previously failed to complete another 5S pilot in the warehouse before. They wanted to retry and showcase the expected benefits from

the pilot project to expand and promote the 5S to the rest of the construction site with the help of the authors. The pilot project was commenced with a kick-off meeting with the warehouse personnel by outlining the aims and objectives of the project in general (see Figure 12). The personnel then were given a comprehensive introduction to the 5S and an implementation plan was agreed on.

Fig. 12. 5S introduction to the Project 1 warehouse personnel

The initial step in the implementation plan was to observe, identify and document the as-is situation in the storehouse (see Figure 13 -14). Bearing inefficiencies in the storage area use with motion blockages and 3 possible tripping and skin piercing health and safety hazards, the storehouse floor and racks were cramped with various materials and equipment scattered around. There was no visual identification of the items clearly showing the item locations, item types and item replenishment levels in the storehouse. Locating the correct safety items was particularly problematic as there were many types of the same item with different sizes (i.e. jackets, vests, trousers and boots) or made with different materials (i.e. safety gloves and safety goggles) or colors (i.e. colored safety helmets for different construction trades). The arrangement of the items had been done haphazardly to a great extent without giving much thought to systematically organizing the item locations as per the demand by the site personnel. The item record books were all over the place. To better capture and compare the benefits, a time-motion study was also executed before and after the 5S implementation on the transactions of some of the most frequently requested items in the storehouse.

Fig. 13. Situation of the storehouse before the 5S

Fig. 14. Situation of the storehouse before the 5S

A typical item transaction process starts with an item demand by the site personnel from the warehouse personnel at the storehouse counter. The warehouse personnel then locate the correct item in the storehouse, bring it to the counter, find the relevant record book and take note of the given item, the demanding personnel's name and personnel number in the record books. If the demanded item is a safety item, an additional safety form is filled out by the warehouse personnel before letting the safety item out, adding to the total process time. See Figure 15 for the item transaction process at the storehouse.

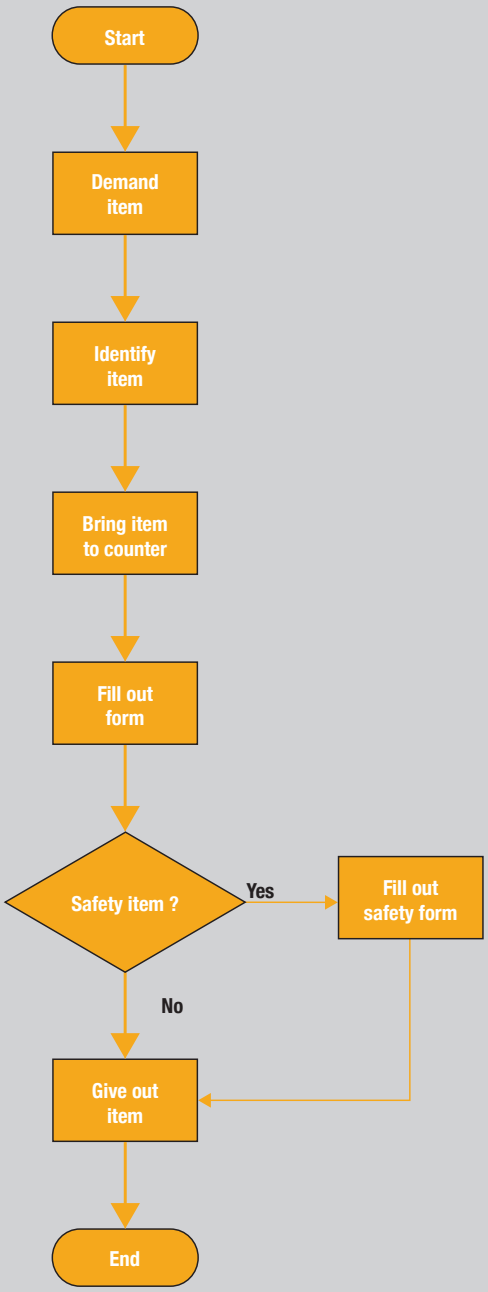


Fig. 15. Item transaction process at the storehouse

For the initial step in the 5S plan, to better reflect the reality, the overall transaction process times, from the start of the item demand to the completion of the item handover, of one experienced warehouse personnel with more than 5 years of experience and one inexperienced warehouse personnel with less than 5 years of experience with equal chances of serving an item request were recorded separately (see Table 1). The personnel had been previously informed that the transactions would be observed and recorded. In the small storehouse area, the transaction process variations (standard deviations) were observed to be minor, particularly with the experienced personnel. The inexperienced personnel, on the other hand, were struggling with identifying the correct safety item, and record books and sheets as there were no clear indication of their locations.

As the first S (sort) in the 5S, the storehouse personnel were asked to evaluate the items in the storehouse in terms of their short-term and long-term necessity. The less needed items that would not be possibly requested in a 6-month period or more were removed from the storehouse. The storehouse floor was cleared of the scattered materials and equipment, which saved around 30% of the total floor area.

By the introduction of pigeonholes, portable drawers and extra shelving, vertical and horizontal space savings were achieved on the storage racks. In the second S (set- in-order), the locations of the items were rearranged as per their use and the demand (see Figure 16).

Fig. 16. Items were regrouped in the storehouse

The more frequently requested items were located closer to the storehouse counter within an easier reach. The items were regrouped and rearranged by their types. The item names, item types, item locations and replenishment levels were clearly marked by highlighted visual clues (see Figure 17 - 18).

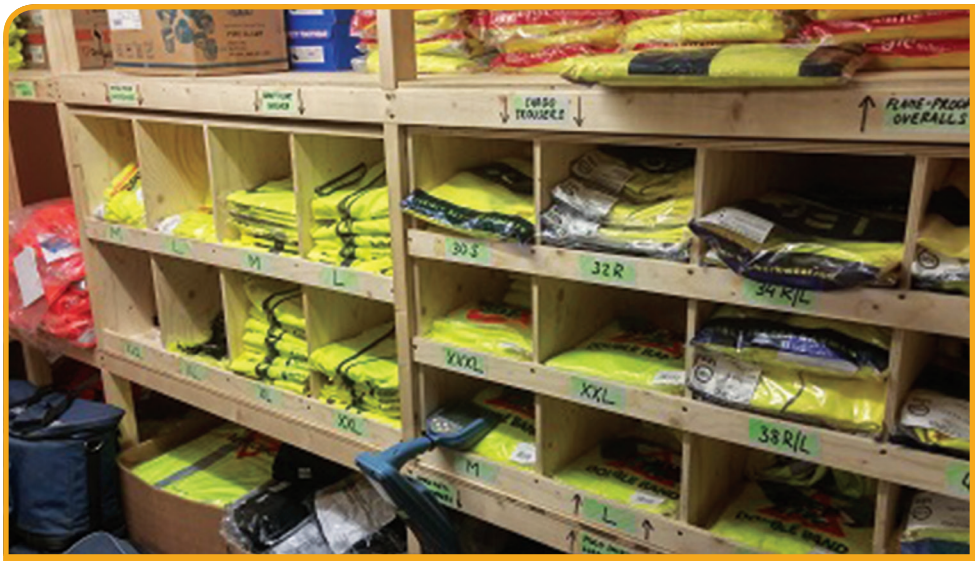


Fig. 17. Setting order in the safety items

Fig. 18. Safety gloves better organised

A particular attention was given to the safety items for their better identification. The record books were collected in the same location, just over the storehouse desk by the counter, and better organized (see Figure 19).

Fig. 19. Records were better organised

For the third S (shine), standard instructions for cleaning and health and safety checks for the storehouse were discussed and issued to the warehouse personnel. For the last two S (standardize and sustain), Project 1 management are regularly controlling the progress and sustaining the created 5S condition in the storehouse with their internal auditing practices. As the storehouse is small, the control practice should be relatively quick and simple.

The item transaction process times for the same, most frequently requested items were recorded again within the same configuration with one inexperienced and one experienced personnel after the 5S pilot to compare the benefits (see Table 1). The average savings in item transaction process times for both the inexperienced and experienced personnel were recorded. The combined average of the inexperienced and experienced personnel specifically for the safety items, other items (i.e. hammer, oil, paint brush) and for all the items were calculated and can be seen in Figure 20. The average savings recorded after the 5S for each item can be seen in Figure 21.

Average Time Savings in Item Transactions after the 5S

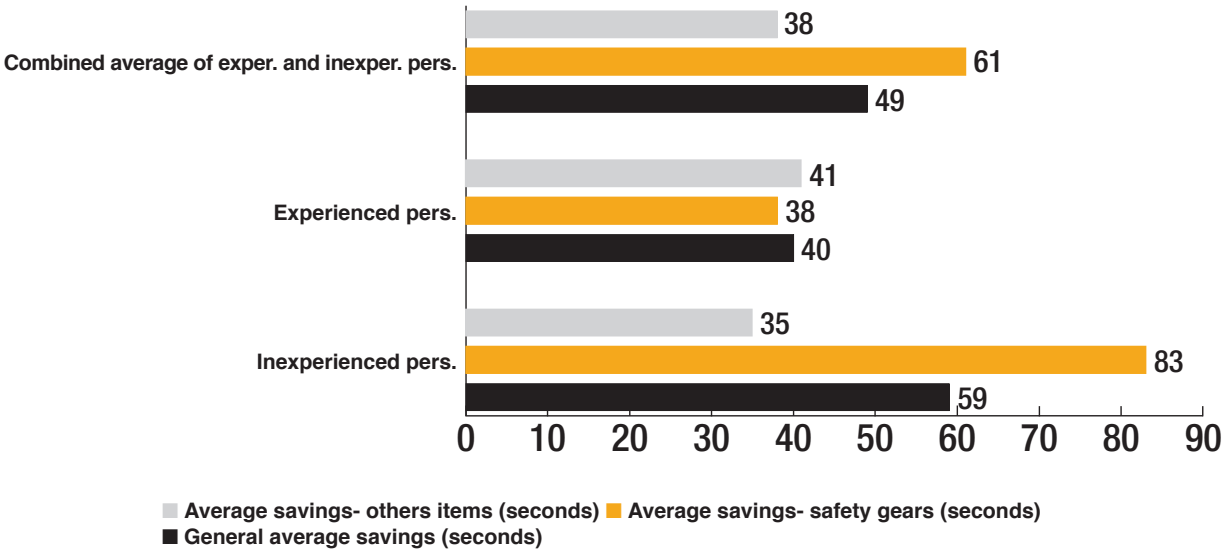


Fig. 20. Average time savings in seconds after the 5S

Average Item Transaction Savings (Sec)

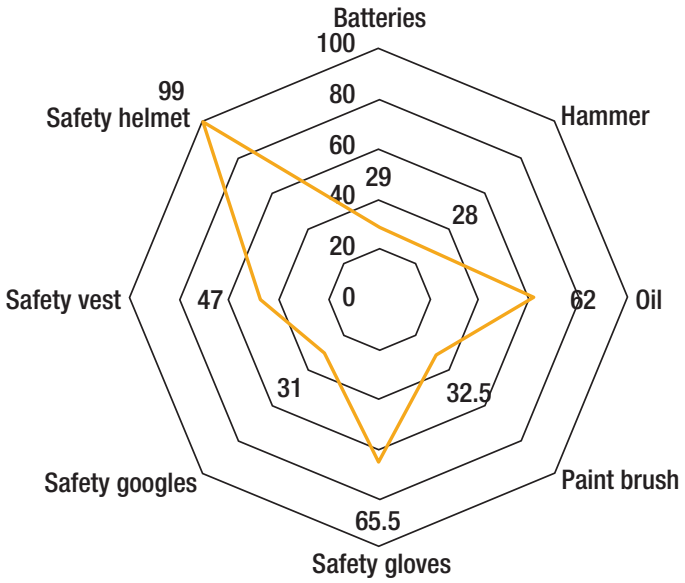


Fig. 21. Average time savings in seconds for each item after the 5S

The recorded savings in percentage after the 5S in the item transactions for the inexperienced personnel, experienced personnel and the combined average savings of the inexperienced and experienced personnel can be seen in Figure 22, Figure 23 and Figure 24 respectively.

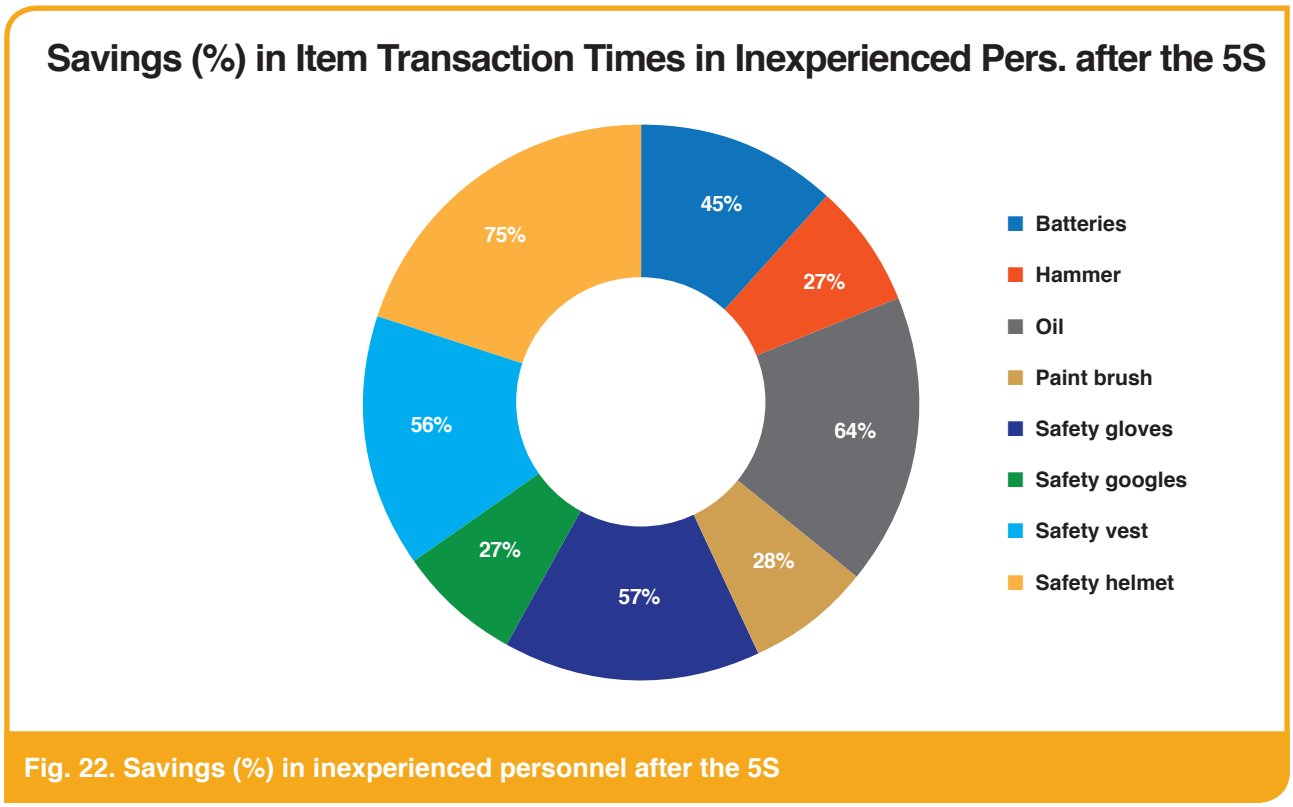


Fig. 22. Savings (%) in inexperienced personnel after the 5S

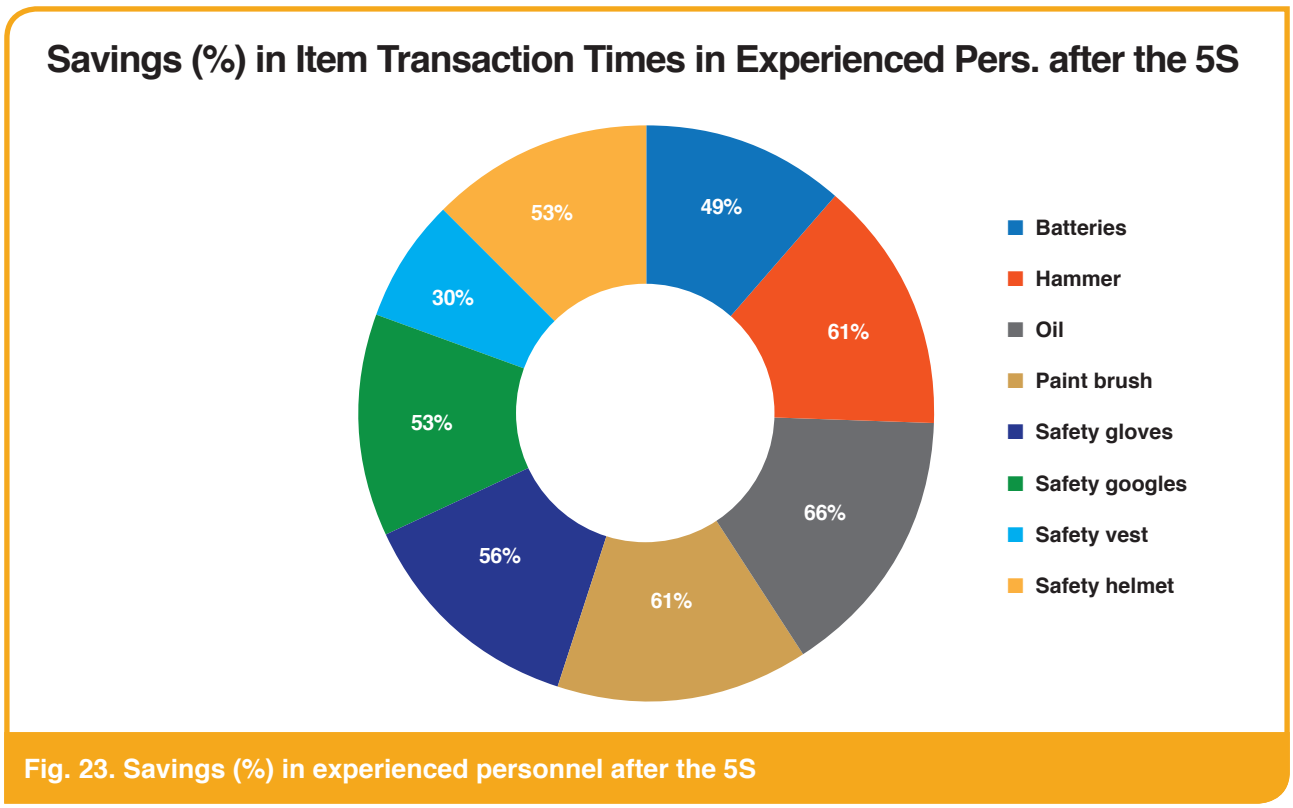


Fig. 23. Savings (%) in experienced personnel after the 5S

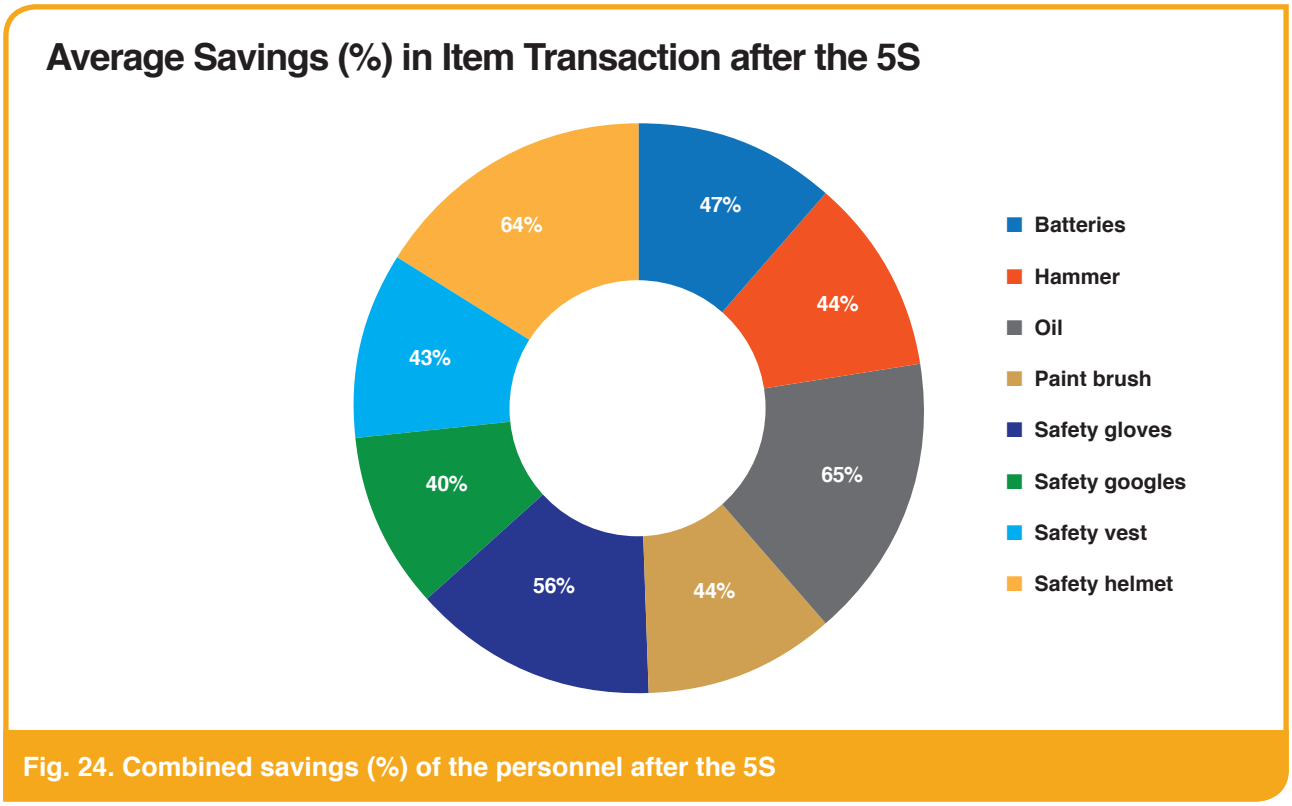


Fig. 24. Combined savings (%) of the personnel after the 5S

Thus, the combined average savings attained for the safety items, other items and all the items in general became 61, 38 and 49 seconds respectively. The savings are particularly conspicuous in the safety item transactions of the inexperienced personnel. Of the total 42 average daily transactions in the storehouse, 21 daily transactions are for the safety items and the remaining 21 are for the other items. The item transactions occur between at least two personnel; one site personnel and one storehouse personnel. Therefore, the total daily average man-second savings recorded on the transactions for the safety items, other items and all items respectively became after the 5S implementation;

- Number of average daily safety item transactions (21) X Two personnel (2) X Average savings in safety item transactions (61) = 2562 (21x2x61) man- seconds,
- Number of average daily item transactions in other items (21) X Two personnel (2) X Average savings in other item transactions (38) = 1596 (21x2x38) man- seconds and
- Number of average daily item transactions in all items (42) X Two personnel (2) X Average savings in all item transactions (49) = 4116 (42x2x49) man- seconds,

Those figures correspond to a 50% reduction in the item transaction durations in general (see Table 1). Although the figures are average, they give an indication of the ratio of the savings, considering only the non-value adding motion, searching and waiting in the storehouse.

Table 1. Detailed comparison of the time savings in the Item transactions after the 5S

	Before the 5S		After the 5S		Time savings after the 5S		Time savings after the 5S	
Item	Inexperienced Pers. (Sec)	Experienced Pers. (Sec)	Inexperienced Pers. (Sec)	Experienced Pers. (Sec)	Inexperienced Pers. (Sec)	Experienced Pers. (Sec)	Inexperienced Pers. (%	Experienced Pers. (%)
Batteries	67	57	37	29	30	28	45%	49%
Hammer	48	70	35	27	13	43	27%	61%
Oil	111	80	40	27	71	53	64%	66%
Paint brush	87	67	63	26	24	41	28%	61%
Safety gloves	146	86	63	38	83	48	57%	56%
Safety googles	75	80	55	38	20	42	27%	53%
Safety vest	136	60	60	42	76	18	56%	30%
Safety helmet	203	85	50	40	153	45	75%	53%
				Total average savings	58.75	39.75	47%	54%
				Average savings-safety items	83	38.25	54%	48%
				Average savings-others	34.5	41.25	41%	59%

The pilot 5S project implementation in the storehouse took 3 months between October-December 2015. The warehouse personnel's approach to the implementation process in terms of their cooperation and compliance with the requirements from the authors was positive. They also stated their content with the improved situation and they would continue experimenting with the 5S steps at the storehouse during the implementation repeatedly. However, the authors' drive, leadership and impulse had been constantly necessary during the implementation process. Being mostly a top-down effort, the 5S implementation at the storehouse would come to a halt without the presence and monitoring of at least one of the authors.

Although the storehouse personnel were mostly left to decide on the new layout of the storehouse and what items to keep or remove in the first and second S as per the instructions from the authors, obtaining the real acceptance or willingness of the personnel for their buy-ins for the 5S was challenging. The storehouse personnel had been sceptical of the expected benefits from the changes in their work routines and work environment throughout the implementation. They also did not feel empowered by the senior management to take those decisions on their own. Moreover, although the organization provides a regular internal lean training, the warehouse personnel were mostly unaware of the lean production and construction systems. The level of awareness of the lean construction related concepts were lower at the operational level. Even though senior management has received varied levels of lean trainings, it was difficult to get their support and leadership for the 5S implementation pilot.

There was turnover among the storehouse personnel, which partly slowed down the implementation process. All those factors affected the hardships faced in driving and sustaining the 5S effort. With the recorded benefits of the 5S pilot, the next step in the future for Project 1 will be monitoring and sustaining the 5S progress and extending the 5S program to the rest of the storehouse. As an initial effort, the rest of the warehouse was divided into zones and some data have been collected by Project 1's management to better identify the nature of item transactions for future improvements (see Figure 25). There is also a potential to extend the application of the 5S to the rest of the construction site.

Fig. 25. Zoning (red and green) in the warehouse as a part of Project 1's future 5S plans

- *led to significant time and work savings in the items transactions (an approximate 50% time savings or 4116 man-seconds or 1.15 man-hour per day on average),*
- *increased the usable floor area by approximately 30%,*
- *raised the horizontal and vertical storage rack space utilization,*
- *helped better mark the item replenishment levels for an uninterrupted item flow,*
- *improved the overall neatness, cleanliness, and health and safety condition (all potential hazards were removed) of the storehouse and*
- *potentially, it can be used to keep track of the calibration and sell-by-dates of the equipment and/or materials.*

4. Extension of the 5S in the Supply Chain

The 5S is a highly systematic approach to visual workplace structuring, which can be successfully applied in many different work settings (Osada, 1991; Galsworth, 2011). Specifically in Highways England's supply chain, it can be applied in warehouses, material/equipment lay-down areas, offices, depots, construction compounds, material test laboratories, canteens, toilets and changing rooms, on actual construction fields, workshops, traffic control rooms, maintenance and supply vans, wellbeing facilities, material trailers and so on. Also, the 5S can be applied in "softer" environments; reports, data tables and databases, software, computer systems etc.

Considering the significant benefits captured form the pilot implementation in a relatively small storehouse, which is approximately 23 meter squares in area, an extensive implementation of the 5S through the supply chain will lead to significant benefits to Highways England's and its service providers' operations. Based on the captured benefits, an estimation of those general potential benefits can be made through extrapolating from the quantified 5S benefits from the current pilot in a 23- meter square storehouse to the total area of the compounds, warehouses, lay-down areas, maintenance vans, offices, labs etc.; where the 5S can be applied in the supply chain.

In order to drive a wider implementation of the 5S with its benefits in Highways England's supply chain, the following points need to be addressed:

- *Increasing the general awareness of the management and workforce on the 5S,*
- *Highways England's continuous leadership, championship and support for the 5S,*
- *Challenging the belief that the 5S is solely a manufacturing concept and cannot be applied in the supply chain,*
- *Challenging the belief that the 5S is just good-housekeeping; it is actually much more than good-housekeeping,*
- *Challenging the belief that the 5S can be applied only in warehouses/storehouses,*
- *Having more 5S pilot projects both in Tier 1 service providers and SMEs in the supply chain,*
- *Further collaboration of the supply chain with academia for the implementation and dissemination of the 5S philosophy,*
- *Organizing regular events and workshops through the supply chain on the 5S,*
- *Using 5S benchmarking data from other industries,*
- *Extending the lean and 5S training in the supply chain to operational personnel,*
- *Creating effective 5S training documentations,*
- *Auditing the service providers for the 5S by Highways England, which can be particularly relevant to the construction and maintenance service providers. This can be done by incorporating a specific 5S rating into the HELMA (Highways England Lean Maturity Assessment),*
- *Recognizing successful 5S efforts within the supply chain,*
- *Contractual obligations for the 5S by Highways England,*
- *Obtaining buy-ins by clearly demonstrating the benefits of the 5S, and involving and engaging with operational people,*

- *Promoting the idea of providing the necessary level of authority to workforce to take decisions on some issues in the first 3S (i.e. sorting, setting-in-order and shining) within their work areas,*
- *Advising management on on-going monitoring and sustaining of the 5S in a systematic manner, which is a critical issue in the 5S implementations in construction.*

5. Evaluation of the Project by Highways England's Key Performance Indicators

Highways England's key performance indicators as stated in the Business Plan 2014 are: making the networks safer, improving the user satisfaction, supporting the smooth flow of traffic, encouraging economic growth, delivering better environmental outcomes, helping cyclists, walkers and other vulnerable users, achieving real efficiency and keeping the network in good condition (Highways England, 2014). An assessment has been made between Highways England's key performance indicators, and the 5S pilot and the 5S in general for future efforts, which can be seen in Table 2.

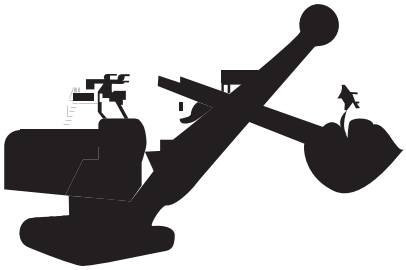


Table 2. Discussion of the 5S pilot and the 5S in general as per Highways England's key performance indicators

Highways England's KPIs	Discussion of the 5S pilot	Discussion of the 5S potential for future implementations
Making the networks safer	One of the benefits of the 5S is creating safer environments. By applying the 5S widely within construction sites, one will have greater confidence that all tests and inspections have been followed and access equipment used have been duly checked for calibration and working order.	This benefit could apply both to service providers and road users in the network.
Improving the user satisfaction	Application of the 5S principles will decrease intervention durations, so the jobs should be completed within their time scales or earlier. This will increase customer satisfaction.	By extending the 5S to different operations in the supply chain, greater user satisfaction can be reached.
Supporting the smooth flow of traffic		The 5S can be tried in traffic management operations by using appropriate signage to better understand the potential benefits.
Encouraging economic growth		The 5S can contribute to economic growth by creating more efficient, cleaner and safer environments in Highways England's operations and the network.
Delivering better environmental outcomes		More efficient operations in construction, maintenance and traffic management through the 5S will contribute to delivering improved environmental outcomes.
Helping cyclists, walkers and other vulnerable users		The 5S can be tried in traffic management operations to better understand the potential benefits.
Achieving real efficiency	This pilot project has demonstrated that 5S implementation can increase overall efficiency.	
Keeping the network in good condition		The 5S has the potential to improve the maintenance operations, traffic management and road user interaction with the network.

6. Conclusion

The 5S pilot implemented in the storehouse saved 50% in the item transaction times (4116 man-seconds or 1.15 man-hours saving per day), increased the usable floor area by 30%, increased the horizontal and vertical space utilization, helped achieve a better item flow, and improved the overall neatness, cleanliness, and health and safety condition. It can also potentially be used to keep track of the calibration and sell-by-dates of the equipment and/or materials. The pilot proved that the 5S could be implemented in the supply chain with a number of benefits. However, some of the existing misperceptions of the 5S, such as "it is just good-housekeeping" and "it just yields benefits in manufacturing environments, not applicable in the construction context", should be challenged. A number of other suggestions to take the 5S efforts further in the supply chain were also given in the report.

An extended implementation of the 5S holds a great potential for highways construction and maintenance operations in terms of motion waste reduction, space savings and improved health and safety. Being a systematic, visual structuring approach, the 5S can be also applied both in physical settings (warehouses, construction sites, maintenance vans, lay down areas etc.) and virtual environments (reports, computer systems, databases etc.) present in the supply chain. In order to realise those benefits, there is a need for more commitment and engagement from the line management and senior management from contractors.

The 5S benefits also fit the strategic KPIs of Highways England well. Therefore, the current level of the 5S implementations should be systematically extended. In line with this, Highways England's active championing and promoting the 5S to their service providers seem necessary. In the 5S implementation efforts, the critical elements seem to be sustaining the efforts (the fifth S) and obtaining real buy-ins of the workforce in the supply chain. The 5S is such a fundamental element of lean construction and VM that Highways England should consider incorporating a specific 5S rating into the HELMA (Highways England Lean Maturity Assessment).

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