Intervention manual:
Strategies and methods for the improvement of Productivity and occupational health and safety in garment factories

Project:
Productivity and occupational health and safety in the garment industry in Bangladesh (POHS-BD)

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1. Introduction

The objective of the project is to create knowledge regarding sustainable co-development between productivity and occupational health and safety (OHS) in the readymade garment (RMG) industry in Bangladesh. As such, this project aims to directly and indirectly improve productivity and OHS practices among Bangladeshi companies. The companies are considered motivated to implement OHS improvements as they simultaneously experience productivity gains. OHS is thereby transformed from being a cost to becoming a means for productivity growth.

The knowledge about co-development between productivity and OHS is developed through a number of activities. The first step was to carry out a baseline study of 50 companies in Bangladesh. The baseline study provided information about the productivity and OHS maturity of the companies. The next step is to improve productivity and OHS in collaboration with 12 companies. A first goal for the intervention is the improvements in the companies, and the subsequent goal is to collect data about both the intervention process and the outcome of the intervention.

The manual therefore includes four parts:

- The approach to the POHS interventions
- The intervention strategy and methods
- The research design and methods
- Appendices with the practical description of methods and tools for both intervention and data collection

The manual is prepared in collaboration with the project staff at Ahsanullah University of Science and Technology (AUST) and Department of Mechanical, Production and Management Engineering at Aalborg University Copenhagen.

2. The approach to the POHS Interventions

This part of the POHS project is based on action research. The idea of action research is to acquire new knowledge by introducing change in real life situations (Greenwood J. & Levin, 2007; Nielsen & Svensson, 2006). By creating real life changes it is possible depending on the design and data collection to get knowledge about several important research questions:

- Is it possible to create the desired changes?
- What are the benefits and drawbacks of the changes?
- What methods can be used to create the desired changes?
- What resources are needed to created the desired changes?

Action research has a long tradition in both operations management (See examples in Bamford, Forrester, Dehe, & Leese, 2015; LaGanga, 2011) and in OHS (See examples in Hasle & Jensen, 2006; Neumann, Ekman, & Winkel, 2009).

Action research is building on a programme theory (Bickmann, 1987) about the effects of certain changes. In the POHS project we have a programme theory telling that productivity and OHS in many cases can be integrated and the effects will be positive for both parameters. Traditional research requires skills in designing, collecting and analysing. In addition successful action research require skills in implementation and process facilitation. Therefore the interpretation of action research raises new questions about the reasons for the outcome. The outcome of the actions may for instance not be as expected which can have two main reasons (Kristensen, 2005). The first one is theoretical failure: The changes did not have the expected results because of faults in the programme theory. In the POHS case it could be due to antagonism between productivity and OHS where improvements in one parameter will cause deterioration in the other parameter. But lack of effects can also be caused by process failure. In POHS it could be due to lack of interest from the intervention companies.

Another issue is the practical application of the results. They may be caused by intensive support from facilitators and large additional resources which are unrealistic in practice outside the project environment. It is therefore important for the assessment of the practical value to consider this issue. In many cases in particular in action research in companies, the companies which agree to participate, are particular motivated and in a situation where they can allow themselves to invest time and money in changes. It is therefore important to interpret the companies as best cases where the deduction would be: If not possible here, it is not likely that it can work in other companies (Flyvbjerg, 2006). This interpretation can be supplemented with realistic evaluation which can pinpoint the mechanisms which make the intervention work (Pawson & Tilley, 1997; Pedersen, Nielsen, & Kines, 2012).

3. The intervention strategy

The goal of the intervention is to achieve measurable improvements of productivity and OHS and to avoid that the changes in one of these parameters have negative effects on the other one. The intervention strategy is based on several sources:

- lean methodology
- OHS and ergonomics
- participation and training

Lean methodology

Lean has a long history from Taylor's scientific management in the early Twentieth Century (Taylor, 1911) over among others Toyota Production System (TPS) (Liker, 2004) and the attempt to rescue the American autoindustry (Womack & Jones, 1996; Womack, Jones, & Roos, 1990) to a wide application today in both manufacturing and many other industries. It is a much debated concept without a commonly agreed definition which varies from a very general production philosophy to a list of practical tools (Shah & Ward, 2007). The promises of lean are not always fulfilled (Vest & Gamm, 2009) which is often explained by implementation failures (Sparrow & Otaye-Ebede, 2014). However, lean is widely used in manufacturing industries, and even though a deep lean culture will be rare to find, many lean tools are applied in practice. Most common tools include:

- value stream mapping (VSM)
- 5s
- flow including just in time (JIT) and kanban
- visual management
- standard operating procedures (SOP)
- continuous improvements (kaizen)

Lean has also and still is much debated regarding the consequences for the workers health and safety. It has been pointed out the lean has a negative effect on OHS (Landsbergis, Cahill, & Schnall, 1999; Stewart et al., 2009). However, a review of the literature indicate (Hasle, Bojesen, Jensen, & Bramming, 2012) that there are both positive and negative effects of lean on OHS, but there are particular good reasons to be aware of the effect in repetitive assembly work. It is possible with a combination of VSM and traditional time and motion studies to increase working speed and reduce micro breaks in the work (Westgaard & Winkel, 2011). The sewing workin garment has strong repetitive elements, and it is therefore important to take this risk into consideration.

The intervention activities will mainly use the six methods listed above in a form which is tailored the garment industry, the involved companies and the possibilities for integration with OHS. The tools are described in Appendix 6.

OHS and ergonomics

Occupational health and safety (OHS) and ergonomics are two partly overlapping concepts. OHS has a long history of being both subject to government regulation and company efforts to manage risks. The research in health and safety aspects of work has for many decades been extensive and knowledge about risks, their effects on healths and the possibilities for prevention is in most cases in traditional manufacturing industry well established. The main problem is to a large extent that the knowledge is not applied in practice. The reasons can be many among others lack of knowledge, cost of application and the separation of OHS from the core business goal as well as practical production. It is these problems the POHS intervention attempts to solve by a stronger integration with productivity. The OHS risks, their effect and the control of risks are described in many general textbooks (See an example in Reese, 2015). A key tool in the management of OHS is risk assessment in which the risks in the workplace is assessed, and the assessment is used to secure control of risks in order to avoid harm to workers. The most important risk factors include:

- accident risks
- noise and vibration
- exposure to hazardours chemicals
- heavy lifting and carrying
- hazardous work postures
- repetitive work
- lighting
- thermic conditions (temperature, air movements)

Ergonomics is a younger concept. It shares the focus on risks and prevention of risks with the traditional OHS approach, but it also has a wider scope. The focus in ergonomics is on fitting the human and the production technology to each other in such a way that the result is both healthy work and effective production (Lehto & Landry, 2012). In this way ergonomics is also bridging OHS and productivity (Neumann & Dul, 2010). Due to this focus on fitting human and technology to each other, ergonomics also has a strong focus on fysiology and the human physiological and cognitive work. Ergonomics also moves beyond risks with the focus on how the combined system of human and technology works best. An example can be the focus on lighting: how does it most effectively support the work of the humans, even though there is no necessarily a risk for eye diseases or other health risks present. But the point of departure is very much as with OHS to avoid overload of the workers, and ergonomics therefore also focus on work postures, lifting, carrying, repetitive work which are important risks to consider in the garment industry. Ergonomics use several methods to study workplaces where observation of work practices (activities and postures) and measurements of workstations, layouts and for instance weigth and force are important.

Checklists are a common tool used both by OHS and ergonomics both risk assessment[1] and for identification of possible improvements (ILO, 2010). In the POHS project we have a particular focus on the following topics:

- workstation design
- materials handling
- layout and housekeeping
- repetitive work
- accident risks
- lighting
- temperaturer

Participation and training

Commitment and engagement of the involved persons are crucial for any change (Cummings & Worley, 2005). It accounts both for the involved managers and workers. The management commitment is for many reasons the key both in the initial phase but also throughout the whole intervention process. Even though the management is decisive, workers cannot be ignored. It is an old learning from change management that exclusion of the workers will jeopardise the change process (S. H. Appelbaum, 1997; Piderit, 2000). Voice and recognition of opinions and suggestions are fundamental element in participation (Morrison, 2011). But participation is not only a question about improvement the likelihood of positive changes, it is also in itself a key to the successful integration of productivity and OHS as involved workers are more efficient and involvement is good for workers health and well-being (E. Appelbaum, Bailey, Berg, & Kalleberg, 2000; Boxall & Macky, 2014)

It is therefore important to design the intervention in such a way that all involved stakeholders in the intervention companies get involved. An important element is to secure the relevant representatives in steering groups and implementation groups but it is also necessary to secure hands on involvement as well as the involvement of the shopfloor workers who are going to live with and utilise the changes.

Training can be a valuable method for both the hands on involvement of representatives and the broad involvement of the workers. In the context of the intervention project, traditional class room training with at teacher giving lectures on particular subjects are less relevant. It is more helpful to work with learning by doing training where the involved persons carry out relevant activities in the companies related to the change process. It can be collection of data, analysis, and development and implementation of improvements.

ILO has a long tradition for action oriented training in OHS and ergonomics. It started with programmes for SME (Thurman, Louzine, & Kogi, 1988) which combined OHS and ergonomics with ideas from industrial engineering and a leaning by doing approach. The idea is to ask participants (managers and workers) to fill out checklists which focus on the most common and relevant improvements and use the identified improvements for practical action plans. This approach has subsequently

[1] See an extensive example: https://osha.europa.eu/en/tools-and-publications/publications/promotional_material/oira-guide/view

be used in different settings (K Kogi, 2006) and the ergonomics checkpoint is also based on the same approach (ILO, 2010).

The lean methodology also has a strong focus on participation (Hasle, 2014; Womack & Jones, 1996), and several of the lean tools are very well suited for involvement of both first line supervisors and workers. It is for instance the case with VSM and 5S in the implementation phase, and in the operational phase visual management and kaizen are relevant tools. Regular short and standing meetings can be organised around a lean board with measurements of daily production, targets and space for suggestions for improvements.

For overview of the training modules and content, refer to Dropbox/Intervention/Training. We have four modules of training.

4. The intervention design

The overall programme theory for the intervention is as mentioned above that it is possible to integrate productivity and OHS in such a way that both can be improved at the same time. The consequence of this theory is that there are either positive relations between productivity and OHS or that possible negative relations can be controlled. It can for instance be in the case of increased repetitive work speed which can be remedied by job rotation or investments in OHS which do not pay off immediately, but do so in the longer time due to increased motivation.

This overall programme theory carry a number further assumptions for the intervention:

- The involved companies will be motivated to invest the necessary time and money to implemented improvements developed during the intervention process.
- Key lean tools can be introduced and applied in the interventions in such manner that the involved staff and workers can use it in practice and so that they support both productivity and OHS.
- Ergonomics focus points such as workstation design and materials handling can be integrated with the lean tools and utilised to increase both productivity and OHS as well as remedy problems related to higher work speed.
- It is possible to involve managers, supervisors and workers to such an extent that they develop the necessary motivation to implement improvements developed during the project.
- Action oriented and learning by doing training can be a key tool to secure active participation as well as identification of relevant improvements.

This programme theory forms the basis for the actual intervention design which is outlined in the following sections.

Selection of companies

The intervention will include 12 companies which are selected by purposeful stratified sampling (Yin, 2014) from three different sources each contributing with four companies.

The first source is the baseline study of 50 companies. Each of the companies has received a written invitation to join the intervention by email and posted letter. Positive reactions led to further contact about joining the project. This group constitute an example of companies which have no particular prior motivation or priming for integrated improvements of productivity and OHS.

The second source is suppliers to the Danish brand Bestseller which has asked its suppliers in Bangladesh whether they would join the project. Positive respondents have been referred to the POHS project which followed up regarding joining the project. This group constitute an examples of companies which among others are expected to be motivated by the influence from one of their important buyers.

The last source is constituted by companies which have participated in the ETI project about social dialogue[2] carried out by Ethical Trade Initiative UK in collaboration with the Danish ethical trade

[2] http://www.ethicaltrade.org/programmes/garments-bangladesh

initiative and funded by Danida. Garment companies have been trained in social dialogue between management and workers, and the participants in the project have been invited to join the project, and again a positive response has led to contact by the POHS project regarding participation in the intervention project. For this group the prior training in social dialogue is expected to qualify the companies for a more efficient involvement of first line supervisors and workers.

For all the three groups the same procedure has been followed for the final agreement about participation in the project. All interested companies have been registered in a spread sheet and project staff has contacted the companies and agreed about the further process. It includes provision of written material (an introductory pamphlet, a power point slideshow and a draft Memorandum of Understanding (MoU) see Appendices 1, 2 and 3). Based on the results of the introductory meetings with the companies, agreements have been made about participation in the project. It has been a requirement that the companies showed sufficient commitment to be active in the project. A new meeting with the top management and the POHS project management was subsequently organised in which the two parties signed an MoU about participation in the project.

Selection of production floor or lines:

- It is recommended to have a production line where product change is not frequent. This will enable the comparison between the pre and pos measurements.
- If the floor is small, we take the whole floor. If the floor is big, we take one or two lines of the floor.
- It is better to get more than one line so we can compare and motivate the workers.

Sequence

The intervention process consists of a number of steps most of them in natural sequence and some of them related to the research which will be elaborated in next chapter. The whole intervention process is expected to last 4-5 months. Below we elaborate on the steps.

- Before start of the intervention

As described above the final inclusion in the intervention project is completed by signing the MoU. In the MoU the companies commit themselves to active participation in the project, including appointing a core group (see appendix 4) chaired by management and a contact person and representatives from the relevant staff as well as workers. The core group is expected to participate in introductory training and data collection. An operational group is appointed in the designated departments and production lines which will do the actual implementation of changes.

For companies which have not been part of the baseline study, a baseline data sampling and maturity assessment are carried out. This is necessary in order to compare with the baseline study and secure the possibility of a before and after comparison.

The core group is forms of at least five members from the following departments:

- Factory head or Operations head

- Production head
- HR or Compliance Head
- IE head
- Quality manager
- Workers representative
- Supervisor representative

We need to appoint the team leader among these members, preferably from the IE department or Production.

The operational group is formed of the following members:

- Line in charge or floor in charge
- IE executive
- Supervisor (Production, Quality, Maintenance, HR/Compliance)
- Workers
- Production planning executive

We need to appoint a team coordinator, preferably IE executive or Floor in charge.

Each participating company is linked up with a research team from AUST consisting of a Professor or Associate Professor, Phd-fellow (POHS coordinator), and a research assistant. In addition, the research team will be supported by a training consultant who is a specialist in lean, as well as the AAU team when members are in Bangladesh.

- Initial training

Initial training is composed of two main modules.

The first module is about Project objectives, Management Commitment and Support, Change management, and general introduction to the following topics: Lean philosophy, OHS, Ergonomics, Buyer Supplier relationships, and Workers participation and Involvement. Top Management and Core Team should participate in the first module. The second module is technical and covers the most frequently used tools, such as Value Stream Mapping, 5S, Time and Motion study, Workstation design and Ergonomics. The core team and Operational team should participate in the second module. The training is carried out by the training consultant and the POHS team. The details of the training modules are presented in

Appendix 4 - Initial training programme of core group and operational group.

Moreover, Representative from the top management are invited to join a network of the participating company which meets four times during the intervention process. At the meetings the POHS researchers will introduce important elements for improvement of productivity and OHS and leave space for exchange of experience between the companies.

- KPI measurements

Before actual improvements are initiated, KPI measurements of both production and OHS

of the selected production unit will be carried out. It is done jointly by members of the company core team, operational team and the POHS researchers.

- Identification of improvements

The collected data (VSM data, Time and Motion study data, Productivity, Man Machine ratio, Efficiency, Absenteeism of the line, Ergonomics and OHS conditions) will be analysed and targets for improvement will be presented. The analysis is done by the POHS team and the consultant.

- Implementation of improvements

The intervention as such starts with identification of possibilities for improvements, which is presented to the company. The actual process will be tailored to each company depending on needs and priorities and carried out by the company core and operational groups supported by the POHS research team. It is expected that most companies will use VSM to identify possibilities for improvements including both productivity and OHS improvements. The use of 5S and ergonomics checklists is also expected. For other tools it depends on the needs and priorities of the company. The available tools are further described in Appendix 6: Lean and OHS tools

N.B For more detail, refer to file Module-Lean in Intervention/Training folder

Improvements are implemented by the company project group assisted by the POHS research team. The POHS team will visit the companies regularly and support the implementation as much as needed. The process of improvement will follow the PDCA cycle and Kaizen event, where the improvements are done in successive PDCA cycles until we reach the target within the defined implementation time. It is also envisaged that during the implementations process new improvement initiatives are taken. It can either be by disseminating the improvements to other production units or by adding new initiatives such as introduction of visual management when other basic improvements have been carried out.

- Measurement of results

The intervention process will be completed by measurements of effects. It will be carried out measuring the same KPI as before the start of the intervention. It is important that the measurements follow the type and style of product in order to achieve validity and reliability of results. If additional improvements have been added before and after KPI measurements are also carried out for these improvements.

5. The research design

The intervention activities have as earlier mentioned two parallel goals. The first one is to initiate integrated improvements of productivity and OHS for the benefits of the companies and the workers. The second one is to acquire new scientific knowledge about the possibilities for integration of productivity and OHS. It is therefore in parallel with the intervention activities necessary to collect data both about the process and the outcomes of the process. The data collection will consist of a general part covering all companies, and a specific part covering each of the three groups of companies which also fits with the three Phd-studies associated with the intervention. The general data sampling covers the following elements (see also Appendix 7: Research data sampling).

Data sampling

1. Log book

Each intervention team writes a shared log book. In the log book all contact with the company is written down, including telephone contacts, meetings, activities, materials and data received. The log book also includes observation from activities carried during the whole intervention process. After each meeting, training activity and implementation activity the research team writes a summary of the observations: What happened, how was it received in the company, what was the outcome. A template for the log book is included in Appendix 7.

2. Baseline data

As mentioned above a standard baseline data sampling including maturity assessment is carried out in the two groups of companies which were not covered by the baseline study. A standard baseline report is prepared for each of these companies. For the four companies included in the baseline study all the data next to maturity assessment is updated. The data is entered into the spread sheet which includes all the quantifiable data. The methodology for the baseline data sampling and maturity assessment is found in the baseline methodology in dropbox.

3. Introductory interviews

Prior to the intervention, introductory interviews are carried out with the core team. The interviews focus on the company's prior experience with productivity and OHS improvements, the expectations for the intervention activities, the formation of the core and operational teams, , the needs of training, and the selection of the production lines for intervention. The interviews are if possible recorded, and a detailed summary written afterwards. An interview guide is included in appendix 7.

4. KPI measurements

As mentioned above KPI measurements are made prior to start of the implementation of improvements. These measurements have dual purpose. They both serve as a part of the intervention process and as part of the result, and the play a crucial role in establishing the business case for integrated productivity and OHS improvements. All KPI measurements are therefore also entered into a spread sheet. After completion of the intervention new similar KPI measurements are carried out and the results are entered into the spread sheet in order to allow for calculation of the effects for the intervention.

5. Follow up interviews and communication

After completion of the intervention follow up interviews are carried out. They included the four persons already interviewed during the introductory interviews. In addition, other key persons involved in the project are also interviewed. The questions focus on the experience with the intervention, the enablers and barriers encountered, assessment of the outcome and plans for further improvements of productivity and OHS. An interview guide is included in Appendix 7: Research data sampling. A new maturity assessment is also subject to be carried out, but that should only happen after six to twelve months after completion and therefore not included here. It should be noted however that the communication with the core team leader should be done frequently and continuously about results and activities during the whole intervention process.

Specific data sampling for the Phd-studies

For each of the Phd-fellows specific sampling of data will be carried out. During the introductory meetings with the management, core and operational team, it should be mentioned that the three PhD fellows will need some specific data which will be collected through interviews and observation.

Specific data needs for Latif

The very tentative title of my PhD research is "Improving Productivity, and Occupational Health and Safety (OHS) through engaging employee in voice behavior". With this title the objective of this research is to investigate and to analyze the influence of the voice behavior of both employee and management in engaging employee in OHS and productivity under the framework of lean implementation in RGM industry in Bangladesh. With this objective and based on 'Implicit Voice Theories", this research is aimed to examine the present pattern of voice behavior of employee and management in the RMG industry of Bangladesh in relation to OHS and productivity, and to examine whether the lean production system and awareness building have any influence to their voice behavior. So in addition to POSH-BD project data, the specific data needed for my PhD project may be as follows subject to the changes during data collection based on the situation and context:

- Data related to employee participation and involvement in management and production process in relation to OHS and productivity. As for example;
    - How you evaluate the initiatives taken by management to involve employees in OHS and productivity?
- Data related to voice behavior of both employee and management-staffs in relation to OHS and productivity under the framework of lean production. As for example;
    - How training encourages employees to learn to solve problems related to OHS and Production?
- Data related to whether lean production environment have any impact on voice behavior of employee and management. As for example;
    - Explain whether lean production and motivational orientation influences employee's belief on fear to speak-up with supervisor?

Specific data needs for Imranul

Title of my PhD is "Buyer-Supplier Relationships, Work Environment, and Performance of the Organisation: A Case of Garment Industry of Bangladesh". The objective of the study is to explore dynamics and mechanisms of buyer-supplier relationships within global value/supply chain perspective and how the buyer-supplier relationships affect occupational health & safety condition and performance in both buyer and supplier companies. Through an extensive literature, the study will track the progress of knowledge in buyer-supplier relationships over time and identify which dimensions have been more focused and which are under focused, and which significant areas still untouched. This study will examine relationship impact on OHS and performance from both buyer and supplier perspectives. More specifically, this study will investigate why tensions arise between buyers and suppliers, how they reduce tensions, and how workers are affected by tensions between buyers and suppliers; what are the scopes of value creations between buyers and suppliers, how buyer-supplier creates value together, what are the drivers and barriers in value creation, and how joint value creation leads supplier development; how buyers help in supplier development, what are the drivers and obstacles to supplier development, how sustainable supplier development can be assured through buyer-supplier relationships, and how buyer's standardization requirements affect supplier's quality, productivity, and OHS. As my PhD is a part of the POHS-BD research project and guided by the objectives of the project, data for my PhD study will be collected from lead buyers and four garment supplier companies from Bangladesh under intervention phase of the project.

Specific data needs for Abu

My main focus is to investigate the potential synergies between OHS and lean tools, and how these tools relate to outcomes of OHS and Productivity. The analysis will be done in group of companies from the garment industries in Bangladesh. The first focus of research is to investigate the potential synergies related to the range of lean and OHS tools that can be implemented simultaneously in the companies. The second and the third focus of research are related to how the simultaneous implementation of OHS and lean tools can influence the OHS and Productivity outcomes. Some lean and productivity tools are traditional time and motion study and standard minute value (SMV), line efficiency, man to machine ratio, quality performance, lost time percentage, Garment rejection rate, Machine utilization. As for OHS tools, I will use tools such as risk assessment on materials storage and handling (heavy material, lifting equipment), Hand tools (cutting and iron), Machine safety, tables and chairs Hight, Lighting, shop floor marking and safety especially in the production floor and ergonomic studies. The analysis will have included both the quantitative and the qualitative data generated from the intervention and follow up steps of the POHS-BD. Detail measurement definition are given in the appendices section.

Organisation of data sampling

The Phd-fellows carry the responsibility to coordinate data sampling, whereas writing of interview minutes and data entry are carried out by the research assistants. Each researcher has the responsibility to update the log book after new contacts with the intervention company, but minutes from meetings and data from observations can be delegated by the Phd-fellows to the research assistants. The senior researchers from AUST attached to each intervention team participate in selected key activities in the intervention companies as well as carry out quality control and secure that all data is collected in due

time and entered in the sufficient quality. The AAU researchers will supervise and give feed back to the data sampling as needed during the intervention process.

All data is shared through dropbox in order to make data accessible and transparent as well as for quality control reasons.

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Appendix 1 - Introductory pamphlet

This table presents the three groups of tools and practices (Lean/OHS – Employee Participation – Suppliers' Development) that will be implemented in order to raise to the next level the maturity of the company (1 is the lowest level and 5 is the highest level).

	Lean / OHS tools	Employee Participation	Suppliers' Development
From 4 to 5	Flow / Job rotation	Training of participation/safety commitee in lean for OHS and producivity	Joint design/implementation of training continuous improvement and flow
From 3 to 4	Value stream Mapping / Self inspection OHS	Team collaboration training	Joint design/implementation of training in team work for quality improvement
From 2 to 3	SOP + Time and Motion study / Workstation ergonomics	Problem-solving training	Joint design/implementation of training in buyer's problem solving and SOP
From 1 to 2	5S / Easy access	Training in basic rights	Joint design/implementation of training in buyer's approach to 5S and basic rights

At the inauguration of the project: Ambassador of Denmark: Hanne Fugl Eskjær-Professor Dr. Shyamal K. Biswas (AUST)– Mr. Faruq Hassan (Senior Vice President BGMEA) – Professor Dr. A. M. M. Safiullah (Vice Chancelor AUST) – Professor Dr. Peter Hasle (Aalborg University)

Our approach and expertise

The researchers will together with your staff look into the layout of selected production lines of the facilities, conduct time and motion studies, look into the ergonomics, and make suggestions for improving forecasting, scheduling and planning.

The project team also holds expertise within Lean leadership and Lean techniques for upgrading the existing facilities with the aim of reducing the waste and support the sustainable development of new quality improvement methods.

The project also looks into how companies can become more agile and dynamic in connection to their global supply chain and the new challenges stemming from new buyer induced requirements.

How your company can benefit from the project?

By joining the project we provide you access to a number of activities, practical tools and trainings that are crucial for enhancing the competitiveness of your company in the new global competitive landscape, where competition is increasingly fierce.

We have just concluded a baseline study in 50 garment suppliers in Bangladesh and have gained a valuable knowledge about the needs of the industry and the employees.

We are now moving to combine our team experience and the learned lessons in order to implement improvements in productivity and occupational health and safety (OHS) in 12 selected garment suppliers in Bangladesh.

It is a unique opportunity for your employees to learn a number tools and practices that can enhance both productivity and OHS.

Participation in the project carries no risks or cost for your company, but we expect active participation and commitment from your involved staff.

As recognition for your participation, your company will receive a participation certificate in improvement of OHS & Productivity.

Contact us

Please contact Dr. Mohammad Sarwar Morshed, Associate Professor, AUST (Cell: +8801792992990 and Email: msmorshed@hotmail.com)

Process of Improvement and Implementation

Step 1
1. Memo of understanding (MOU)
2. Team Formation

Step 2
1. Baseline Study

Step 3
1. Preparation of intervention
2. Team training
3. Definition of scope for intervention

Step 4
1. Intervention
2. On the job training

Step 5
1. Follow up
2. Pos-improvement measurement

Appendix 2 – Slideshow

POHS Project

Productivity and occupational health and safety (POHS) in the garment industry in Bangladesh

Collaborative Key Partners:

AALBORG UNIVERSITY
DENMARK

&

A U S T
1995
BANGLADESH

Funded by: DANIDA
Danish International Development Agency

From 2015 To 2018

Background: integration of occupational health and safety (OHS) and productivity

- **Low productivity, quality problems and health & safety risks have often the same sources like:**
  - **Poor housekeeping**
  - **Inappropriately designed workstations**
  - **Undesirable layouts**
  - **Time consuming and heavy internal materials handling**
  - **Fatigued and unhealthy workers**
  - **Low motivation**

Project Goal

- To improve Occupational Health and Safety (OHS) practices and productivity among Bangladeshi RMG suppliers.
- To motivate the suppliers to implement OHS improvements for continous productivity gains.
- To show the suppliers that OHS is thereby transformed from being a cost to becoming a means for productivity growth.
- To help the suppliers to estabilish the long-term relations with Buyers.

Inauguration of the Project

- Ambassador of Denmark: Her Excelency Hanne Fugl Eskjær
- Professor Dr. Shyamal Kanti Biswas (AUST)
- Mr. Faruq Hassan (Senior Vice President of BGMEA)
- Professor Dr. A. M. M. Safiullah (VC of AUST)
- Professor Dr. Peter Hasle (Aalborg University)

Intervention (Improvement) in RMG firms

- **Step 1: The baseline study: Data collected from 50 RMG Factories in Bangladesh.**

- **Step 2: Intervention(Improvement) in RMG firms- The improvement will be done in the selected 12 RMG factories by using Lean and OHS tools and techniqes. Providing in house action based training to the factory people (Free of cost).**

- **Step 3: Sustainability follow up- The sustainability of the outcomes will be evaluated after 6-12 months of the completion of implementations.**

- **Step 4: Knowledge dissemination- To four terget groups: (i) The scientific community (ii) Stakeholders of the garment industry (iii) Danish buyers, employers' associations and unions collaborating with Bangladesh & (iv) Policy makers in both countries .**

Project Team Strength and Networking

- **POSH has build an efficient team including the experts from AUST and Aalborg universities:**

  Three Professors, Three Associate Professors, One Assistant Professor, One Post-Doc Fellow (Lean Expert and Black belt), One IE Consultant, Three PhD fellows and Three Research Assistants

- **POSH project has strong collaboration with:**

  BGMEA, BUFT, ETI, GIZ, Danish Embassy, Danish Mode and Textil and Bestseller (Danish Buyer).

The team will work for the factory voluntarily (Free of Cost)

Benefits for the Supplier-firms from the Project

- Factory will improve the Productivity, which will lead to decrease the production cost.
- Factory will learn on how to improve the working conditions as well as productivity systemetically.
- Factory people will be trained on advanced Lean tools and OHS tools (Free of Cost). It will be benificial for further improvement.
- Factory will learn how to meet complaince code of conduct with regard to OHS and thereby enhances the sustainibility.
- Factory will be able to develop a long-term relation with Buyers by using the best pactices of OHS.

Sequencial Steps for Intervention (Improvement)

➢ **Preliminary meeting:**

- Initially, the supplier firm will have to give its consent to participate in the project. Then Meeting will be conducted between the project people and the top management of the supplier firms regarding the scope and the limitation of the intervention at the factory.

➢ **Team formation:**

- Forming a team with the paticipants both from project management and the factory people (5 Emoloyees : Team leader and 5 Team members from each supplier).

➢ **Pre-training:**

- Providing on job training about Lean tools and OHS tools to be used during intervention. Training session will be organised for the core committee, supervisors and workers at the concerned section and will continue with the follow up meetings, training, intervention and evaluation of the OHS condition and productivity.

Sequencial Steps for Intervention (Improvement)

➢ **Pre-measurement:**

- Intervention company's level will be measured through data collection.

➢ **Intervention:**

- Implementing tools to the production unit through "Learning by Doing" activities.

➢ **Post measurement:**

- Checking the impovements of the working conditions and productivity gains through data collection again.

➢ **Follow-up:**

- Continous dialogue and meeting will be held with the concerned mid-level management to share the updates.

➢ **Sustainability of Results:**

- Project team will revisit the factory 6-12 month later in order to assess sustainability. Communicating with the management of Buyers and the Supplier firms about the best practices.

Closing the Intervention

- After the follow-up of intervention and the final assessment of OHS condition and productivity, a joint meeting will be held between the top management and the project team.

- A Certificate will be awarded to the company for the successful participation in intervention and upgradation of OHS.

Appendix 3 - Memorandum of Understanding MOU

Memorandum of Understanding

This Memorandum of Understanding is signed on this day of….....201..

BETWEEN

(Name of the company), Bangladesh (hereinafter is called 1st part) and is represented by its Managing Director……

AND

Aalborg-AUST Research Project (hereinafter is called 2nd part) and is represented either by Prof. Peter Hasle of Aalborg University, Denmark or Prof. Dr. Md. Amanullah, Ahsanullah University of Science and Technology, Dhaka, Bangladesh.

1. The aim of the MOU is to collaborate regarding an programme for improvement of productivity and Occupational Health and Safety (OHS) in part one's factory.
2. The improvement programme is related to the research project carried out by the second part (Aalborg-AUST Research Project) which is funded by DANIDA, Denmark. The project aims to investigate how garment companies can enhance productivity by improving Occupational Health and Safety (OHS) conditions of the factories.
3. The second part is committed to provide researchers and experts (from Aalborg University, Denmark and Ahsanullah University of Science and Technology (AUST), Bangladesh) for the assistance to the improvement programme. One researcher will be appointed as responsible for the daily collaboration between the two parties. In this assistance the second part will use necessary and relevant operations management, human resource management, and supply chain management tools and techniques.
4. The assistance will include assessment, observation and measurement of present conditions and development of suggestions for improvements. The suggested improvements will use scientific tools and technique (such as Lean, JIT, TQM, 5s, VSM, SOP, Kaizen, flow design, visual management, workstation design, material handling, worker participation and engagement) whichever fits well with the existing conditions and needs of the factory. It will also include the necessary training of staff and workers.
5. The second part is obliged to keep all the information collected from the first part fully confidental. All information will only be used in anonymous form unless agreed differently by first and second part.
6. The first part is committed to provide the relevant numbers of competent employees from different sections to form a core committee. One member will be appointed to secure the daily collaboration between the two parties. The members from first part in the core committee will get all sorts of assistance from second part to enrich their existing knowledge for improving OHS and productivity.

7. The research and development activities toward OHS and Productivity improvement will secure full liberty and choice to the companies to determine at which level and to what extent any suggestions for improvements or training should be implemented.
8. The first part will receive a certificate recognizing the degree of collaboration and the improvement of OHS and Productivity after the completion of the intervention. This would hopefully help the first party to enhance and strengthen the relationship with foreign buyers, which would impact on the growth and sustainability of the first party.

Considering the clauses as laid down is this MOU, we the first part do hereby agree to honor the MOU.

Signature of the 1st part

Considering the clauses as laid down in this MOU, we the second part do hereby agree to honor the MOU.

Signature of the second part

Appendix 4 - Initial training programme of core group and operational group

1. Formation of core group

For the intervention project in a particular project a core company group should be created. The General Manager will assign someone as his representative to be the leader of the core group. This person can be from Industrial Engineering or Production. This group is a combination of persons from different department. At least one person from the relevant departments such as Production department, Compliance and HR department, Industrial Engineering department and Merchandising department should participate in the group. A supervisor from the department with the selected production line(s) should also be included. He may be the representative of few supervisors who will take part in the intervention work.

From the core group that will be formed, one person from the group should act as a project coordinator. He will be coordinating the group while the intervention work would go on. He will also need to do secretarial work and maintain documentations and arrange any formal or informal meeting if necessary. It can be for instance from HR and compliance or Industrial Engineering department.

Role of core group members

Project coordinator will be responsible to convey the meeting and write minutes and keep records. Meetings are vital for management and communication. The project will arrange meetings in regular basis. It may be weekly or may be daily at the end of the day. The agendas for the meeting would be the activities done as a part of the intervention project and discussion relating outcomes for doing so. The project coordinator should maintain all the documentations. Every meeting should have minutes and the minutes should be circulated among the group members. The activities, the changes that would be made and the outcomes due to the changes would be discussed in the meeting. The project coordinator should keep all the records for future evaluation.

The compliance/OHS manager of the core company group will be responsible for providing information and support related to Occupational Health and Safety. While doing intervention work in the shop floor, the compliance manager should give support to the team by providing information and logistics support.

Production manager of the core committee group will be responsible for providing information and support related to production and products. He should supervise the whole production of the line which would be under the intervention project. He will conduct the production according to the changed mode in the intervention work period. He will maintain to run the production smoothly. His duty includes checking and setting quality standards. The production manager will check the production outcome of the line and disclose the documentations in the meeting.

There will be a representative of the supervisors. He will be responsible to provide information related to shop floor and implementation of intervention. He will supervise the production and will give assistance to the intervention work. He will guide workers to adjust with the changed methods of working during intervention implementation period.

Among the workers, a representative would be selected who is a member of workers' participatory committee or any other committee like safety committee. If there are any issues regarding workers and to raise their suggestions or demands then workers' representative will be responsible to raise their concerns on behalf of shop floor employees.

2. Training topics:

2.1 Module 1: The module 1 aims to introduce to top management and core team the main topics and challenges of the intervention. It contains the following themes:

Organizational commitment, Change management, Formation of teams, Employee engagement, involvement and participation, Buyer-supplier relations, Lean philosophy, OHS and Ergonomics.

For initial training on lean and OHS, refer to Dropbox/Intervention/training – file Lean Thinking Workshop (ppt)

For initial training on workers participation, refer Dropbox/Intervention/training – file Presentation on EP (ppt)

2.1.1 Organizational commitment

- Define Organizational commitment;
- Why is organizational commitment important?
- How to improve organizational commitment?
- Organizational commitment in relation to OHS and productivity

2.1.2 Change Management

Change management is the discipline that guides how we prepare, equip and support individuals to successfully adopt change in order to drive organizational success and outcomes. While all changes are unique and all individuals are unique, decades of research shows there are actions we can take to influence people in their individual transitions. Change management provides a structured approach for supporting the individuals in your organization to move from their own current states to their own future states. Change management is an actually a structured approach for ensuring that changes are thoroughly and smoothly implemented, and that the lasting benefits of change are achieved. The focus is on the wider impacts of change, particularly on people and how they, as individuals and teams, move from the current situation to the new one. The change in question could range from a simple process change, to major changes in policy or strategy needed if the organization is to achieve its potential.

2.1.2.1 Why change is needed? Change is a planned and managed process. The benefits of the change are known before implementation and serve as motivators and assessment of progress. As a result of this, the organization can respond faster. It helps to align existing resources within the organization and allows the organization to assess the overall impact of a change. Besides change can

be implemented without negatively effecting the day to day running of business. Change is needed to have maintained organizational effectiveness and efficiency. Applying proper change management reduces the time needed to implement change. Besides employee performance increases when staff feel supported and understand the change process

2.1.2.2 Level of change management: The Change Management has various levels. The maturity model of change management has five levels, from no change management to organizational competency. Each level involves more attention and management of the people side of change.

LEVEL 1: AD HOC OR ABSENT CHANGE MANAGEMENT

At Level 1 of the organizational change management maturity model, project teams are not aware of change management and do not consider it as a formal approach for managing the people side of change.

Projects at this level can have one or more of the following characteristics:

- Project leadership is focused only on the technical side of the project including funding, schedule, issue tracking and resource management
- Communications from the project are infrequent and delivered on a need-to-know basis
- Supervisors and managers have little or no information about the change and have no change management skills to coach their employees through the change process
- Employees react to change with surprise and can be very resistant

LEVEL 2: CHANGE MANAGEMENT ON ISOLATED PROJECTS

In Level 2, elements of change management begin to emerge in isolated parts of the organization. The effort to manage the people side of change is infrequent and is not centralized.

Characteristics of this level are:

- A large variation of change management practices exists between projects with many different change management approaches applied sporadically throughout the organization; some projects may be effectively managing change while others are still in Level 1
- There are elements of communication planning, but there is little sponsorship or coaching
- Managers and supervisors have no formal change management training to coach their employees through the change process

LEVEL 3: CHANGE MANAGEMENT ON MULTIPLE PROJECTS

At Level 3, groups emerge that begin using a structured change management process. Change management is still localized to particular teams or areas in the organization. Organizations at this level can have one or more of the following characteristics:

- Multiple projects are using structured change management processes, although these approaches and methodologies may be different
- Some elements of knowledge sharing emerge between teams in the organization; teams in some departments are sharing experiences and lessons learned
- While change management is applied more frequently, no organizational standards or requirements exist; pockets of excellence in change management co-exist with projects that use no change management

LEVEL 4: ORGANIZATIONAL CHANGE MANAGEMENT STANDARDS

In Level 4, the organization has selected a common approach and implemented standards for using change management on every new project or change. Organizations at this level can have one or more of the following characteristics:

- There is an enterprise-wide acknowledgement of what change management is and why it is important to project success
- They have selected a common change management methodology and are developing plans for introducing the methodology into the organization
- Executives, project teams and change leaders have access to training and tools, and managers and supervisors have formal training in change management

LEVEL 5: ORGANIZATIONAL COMPETENCY

In Level 5 change management maturity, change management competency is part of the skill set of the organization. Organizations at this level can have one or more of the following characteristics:

- Effective management of change is an explicitly stated strategic goal, and executives have made this a priority
- Employees across the enterprise understand change management, why it is important to project success and how they play a role in making change successful
- Change management is second nature, so commonplace that it is nearly inseparable from initiatives

2.1.2.3 Action for managing change: Base on the change management assessment, the team will propose a set of tools for change management.

2.1.3 Employee engagement, involvement and participation

2.1.3.1 What is employee engagement?

Engagement is a concept that overlaps the concepts of motivation, involvement, commitment, citizenship behavior and psychological contract and so forth (Smith and Markwick, 2009). Employee engagement is defined in different perspectives and in different ways. It is defined as a construct as well as a workplace approach. It is defined as the cognitive and emotional attachment to work (Kahn, 1990); as the involvement, commitment, passion, and enthusiasm (Macey and Schneider, 2008); as the commitment and organizational citizenship behavior (Robinson et al, 2004); as the discretionary effort (Frank et al, 2004); as the psychological presence (Rothbard (2001); as the involvement and efficacy (Malach et al (2001); as the affective and cognitive state (Schaufeli et al (2002); as the meaningfulness, safety and availability at work (May et al., 2004); as the organizational outcomes (Harter, Schmidt, & Hayes, 2002); as the center of workplace relationship which propels the performance and productivity (MacLeod and Clarke report, 2009); as to create a workplace environment where workers feel free to connect each other and with their work (CIPD, 2009; CIPD, 2010); as an "alignment of values, goals and aspirations" (WhiteBlessing 2010); as to drive to improve and change (Gallup, 2008); as the satisfaction and sense of inspiration (Tower Perrin, 2004). Employee engagement is considered as the driving force to promote the better performance and productivity including improving Occupational Health and Safety standards (CIPD, 2010, Raines, 2011; Gallup, 2006). Engaging workers in safety promote both obligated safety behaviors and discretionary action of individual (Neal, Griffin, & Hart, 2000 in Burke and Signal, 2015).

2.1.3.2 Engagement and OHS:

- Employee safety engagement has a critical role in employee safety performance (Wachter and Yorio, 2014).
- Initiatives directed at supervisors may be more effective at improving safety than initiatives directed at employee (Zohar and Luria, 2004, in Conchie et al, 2013).
- Gallup found a positive role of engagement in safety performance.
- A study found that engaged businesses exerts 62% less safety incidents than units with lower employee engagement (Raines, 2011 in Wachter and Yorio, 2014).
- In a report SHRM found that $1.7 million was saved in safety cost for improving employee engagement in the Molson Coors beverage company.
- It was found that engaged employees were five times less safety incidents than the non-engaged employees (Vance, 2006; Raines, 2011 in Wachter and Yorio, 2014).

2.1.3.3 Engagement and Productivity:

- Employee engagement promotes workplace relationship which propels performance and productivity and change the pattern of working life.
- Benefit of employee engagement is enormous that benefit individual employee, organization and the nation as a whole (MacLeod and Clarke, 2009)
- Engagement is a positive attitude of the employee towards the organization and a belief towards its values where they work for the organization to improve its performance and profits (IES, 2004).
- Corporate Leadership Council (2004) found that engaged employees improve performance by 20% and retention by 87% than disengaged employees.

- Research found that operating and net profit margin and revenue earning improve a lot due to higher engagement level (Tower Perrin, 2005).
- In the USA about 14% adult workers are found to be disengaged which cost about $300 billion in the US economy and low level engagement cost £ 59.4 billion to £64.7 in the UK in 2007 (Gallup, 2008).
- A study by Watson Wyatt (2008) reveals that the financial performance of a company improves four times with the highly engaged employees (Watson Wyatt, 2008 in CIPD, 2009a, p 2).
- IES shows that 10% increase in investment to engagement raise profits by £1500 per employee per year MacLeod and Clarke, 2009).

2.1.3.4 Drivers of employee engagement:

- Opportunities for the employees to deliver their ideas and opinion upwards, the opportunities of being well informed of organisational affairs, commitment of the line manager to the organization, mutual trust and respect, managerial fairness, internal communications, clear business strategy and goals of the organisation, flexible working arrangement are some important drivers of employee engagement (CIPD (2009).
- Leadership, engaging managers, employee voice and integrity are four key drivers that improve organisational performance (MacLeod and Clarke, 2009).
- Feeling valued and involved is the key driver of employee engagement. Components of these drivers include the involvement of employees in decision making process, opportunities to express and feed views and ideas, opportunities of having reward and recognitions, opportunities to personal development and training, and finally commitment to employees' well-being (IES, 2004).

2.1.3.5 Strategy for employee engagement;

Employee engagement is not merely initiate some tools to encourage employee but it is a philosophy and practice. Management need to belief this philosophy and understand the benefits of employee engagement. It is not a shortcut way to improve organizational performance but it is a long journey. For this it need a long term plan and policy. To employee the level of employee engagement, the following dimensions need to be practiced and improved:

- Demonstration of visible Leadership commitment;
- Ensuring good employee-supervisor relation;
- Building the culture of mutual trust and respect;
- Encouraging employee voice and value their feedback and suggestions;
- Ensure fair and transparent HR policies & practices;
- Ensuring managerial fairness;
- Ensuring opportunity for skills and career development;
- Ensuring competitive pay and benefits;
- Encouraging employee involvement;
- Initiating reward and recognition policy;
- Ensuring and demonstrating employee wellbeing;

2.1.3.6 Employee Voice:

Employee Voice has been seen as the most important tool to improve employee engagement. Traditionally, voice was seemed to influence the terms and conditions of employment relations and to raise dissatisfactions for the same (Hirschman, 1970). But in course of time now employee voice is seemed to involve employee and improve performance (Johnstone and Ackers, 2015).

2.1.3.6.1 Importance of employee voice:

- Understanding employees' voice is very important for harnessing continuous improvement and competitive advantage.
- Competitive advantage can be gained through employees' idea and suggestions for the development of processes, products and services (Krone, 1991; Waldron, 1999).
- Employee voice is gaining importance from both pursuing higher level of performance and better level of employee representation (Marchington et al., 2004).
- Employees with perception of having opportunities to raise voice to the management, devote themselves for higher performance of the organization (Bedarkar and 2014

2.1.3.6.2 Employee voice and engagement:

- Employee voice intend to improve the performance of team and work group have both direct and indirect influence on employee engagement level (Rees et al., 2013).
- Employees are found to show positive attitudes and behavior when they feel valued and their contribution are acknowledged (Saks, 2006; Kuvaas and Dysvik, 2010).
- Both indirect and direct voice is the preconditions of employee engagement as well as involvement, commitment and motivation (Johnstone and Ackers, 2015; p-63).
- Employee voice as one of the strongest drivers of employee engagement where employee voice has to seek, listen and counts (Macleod and Clarke, 2009).
- Employee voice, among a lot of drivers, is one of the two key drivers of employee engagement (Truss et al., 2010).
- Opportunity to raise voice and attitudes to value their voice by the management is very important to engage employee to the organization for improving performance (Macleod and Clarke, 2009, Truss et al., 2010, Robinson et al, 2004, Purcell, 2010, Hewitt, 2004, CIPD, 2010, CIPD, 2011, IES, 2009, Sage, 2010, BlessingWhite, 201).

2.1.3.6.3 Dimensions of employee voice:

According to Marchington (2004) based on purpose employee voice can be channelized in four different ways:

- Articulation of individual dissatisfaction;
- Expression of collective bargaining;
- Contribution to management decision making;
- Demonstration of mutuality and cooperative relations.

2.1.3.6.4 Definition of voice for this study:

- (Morrison, 2011) conceptualized voice as the *"discretionary communication of ideas, suggestions, concerns, or opinions about work-related issues with the intent to improve organizational or unit functioning"*
- Detert & Burris (2007) defined voice as *" the discretionary provision of information intended to improve organizational functioning to someone inside an organization with the perceived authority to act".*

2.1.3.6.5 Conditions of employee voice:

Motivation to raise voice only act when perceived benefits exceed the perceived risks of voice behavior (Detert & Burris, 2007).

Due to implicit beliefs or socially acquired beliefs people might remain silent because of perceived risk of voice to social hierarchies

2.1.4 Buyer-supplier Relations

What is Buyer-supplier Relations?
Buyer-Supplier Relations (BSR) is defined as the supplier's perception of the buying firm's behavioral and operational relationship attributes: buying firm's commitment, cooperation and operational linkages. O'Toole and Donaldson (2000) defined relationships as bilateral (characterized by mutual cooperation), recurrent (close but absent the closeness of a bilateral relationship), discrete (minimal interaction), or hierarchical (one partner is dominant). Buyer–supplier relationships have also often been viewed as a 'quasi-entity', or even a 'quasi- firm' (Lamming, 1993; Speckman, Spear and Kamauff, 2002), creating the perception that inter-firm relationships are generic, in the sense of only one relationship being in existence between the firms.

Why is it important?
Buyer-Supplier Relations has been linked to a wide variety of benefits such as higher quality and lower costs (Larson, 1994), delivery (Artz, 1999) and logistics service performance (Stank et al., 2001), the opportunity to expand product and service offerings, the ability to share risks (Parkhe, 1993) and overall performance (Hewett and Bearden, 2001). Collaboration has also been associated with other relational constructs, for instance, dependence (Heide and John, 1988) and trust (Kumar et al., 1995) influence and collaborative success. The common assumption is often that collaboration and other relational constructs reduce transaction costs and lead to improved business performance.
Buyer-supplier engagement (BSE) is important for your firm's key suppliers due to:
1. Participating in the sourcing decisions of your suppliers.
2. Use of informal information sharing with suppliers and customers.
3. Use of formal information sharing agreements with suppliers and customers.
4. Improving the integration of activities across your supply chain.
5. Communicating your firm's future strategic needs to your suppliers.
6. Creating a greater level of trust among your firm's supply chain members.

7. Creating a compatible communication/information system with your suppliers and custome

What factors affect buyer-supplier relations;
Factors related to Buyer-Supplier Relations contain three components: investment in the trading partner, affective commitment and the expectation of the relationship extending into the future (Kumar et al., 1995). The buying firm's commitment was defined as the suppliers' perception of the degree to which the buying firm feels pledged or obligated to continue business with a specific supplier. This commitment can be reflected by loyalty, willingness to make investments in the supplier's business, and confidence in the stability of a long-term relationship (Anderson andWeitz, 1992).

Drivers of buyer-supplier relations;
Buyer–supplier relationship architecture describes mechanisms for building relationship, the role of the buyer and the supplier, and the relationship protocol between a buyer and supplier. Buyer–supplier relationship architecture to be composed of quality expectations in a buyer–supplier relationship, information sharing and trust between buyer and supplier, and aspects related to centralized planning in JIT termed as ''supply chain proximity''.Another driver of BSR is the selection of appropriate supplier and to check the followings issues
1.Company size 2. Ethicalstandards 3. Testing capability and Scope of resources 4.Technical expertise. 5. Commitment to quality. 6. Supplier's process capability. 7. Ability to meet delivery due dates. 8. Price of materials, parts and services. 9. Geographical compatibility/proximity. 10. Supplier's willingness to share confidential information. 11. Percentage of supplier's work commonly subcontracted. 12. Commitment to continuous improvement in product and process. 13. Reserve capacity or the ability to respond to unexpected demand.

Impact of good buyer-supplier relations on organizational performance;
A number of studies have examined the linkages between relationships and performance. These have demonstrated gains to the buyer from successful relationships in terms of financial (Carr and Pearson, 1999; Martin and Grbac, 2003; Johnston et al., 2004), and lead time performance (Larson and Kulchitsky, 2000). In addition, these relationships can result in improved responsiveness and customer loyalty (Martin and Grbac, 2003), innovation (Corsten and Felde, 2004; Johnston et al., 2004), and quality (Johnston et al., 2004). From a supplier's perspective, they can lead to reductions in inventory cost (Kalwani and Narayandas, 1995) and lead time (Kotabe et al., 2003), as well as improvements in product/process design, quality (Kotabe et al., 2003), financial performance and future relationship prospects (Duffy and Fearne, 2004). Successful relationships have also been shown to yield improvements in supply chain performance (Narasimhan and Nair, 2005; Benton and Maloni, 2005; Maloni and Benton, 2000).The impact of buyer–supplier co-dependency and relationship quality significantly affects the supplier performance. The market orientation is positively associated with measures of channel performance such as service quality and the extent of buyer satisfaction. The study also demonstrates that in the processes of managing business relationships, cognitive dimensions like trust, commitment, and low level of conflicts provide 'win-win' situation for buyers and suppliers.

2.1.5 OHS (Abu)

Definition of Occupational Health and Safety (OHS):

The science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment (ILO, 2009).

OHS is aimed to-

- ❖ Promote and maintain the highest degree of physical, mental and social well-being;
- ❖ Promotes better human resource management
- ❖ Motivate workers with a higher degree of job satisfaction
- ❖ Encourage to produce better-quality product and services.

Some OHS related statistics:

- About 160 workers experience a work-related accident in every 15 seconds worldwide (ILO, 2014, in Drupsteen, 2014).
- About 2.3 million fatal and 313 million non-fatal occupational accidents in 2010;
- About 2 million suffer from work related disease annually
- Cause approximately 6,300 deaths every day worldwide (ILO, 2014).
- Workplace accidents caused an economic impact of 845.6 billion dollars in 2010 (Prayitno, et al, 2015).
- In 3013, work-related deaths recorded 3,738 and medical consulted injuries 4,800,000 those cost about $206.1 billion including wage and productivity loss, medical and administrative expenses in the USA (National Safety Council, 2015).

Bangladesh status:

- Working conditions of RMG sector of Bangladesh have been *among the worst in the global garment industry (ILO, 2013).*
- About 338 workers died in workplace accident and 159 workers were injured in different workplace accidents during January-March 2016 period in Bangladesh OSHE, 2016)
- Bangladesh witnessed a greater number of workplace accidents in recent past specially in RMG sector which raised international attention (Hossain, et al, 2015).
- Due to lack of safety compliance and lack of commitment to workplace safety, industrial accidents in RMG factories are common in Bangladesh (Ansary and Barua, 2015)

Legal and social obligation:

- ⦿ International obligation:
  - International Labor Organization (ILO);
  - Other International Agencies related to OHS;
  - Donors recommendations;

- International NGOs;
- International buyers.

- Country specific obligations:
  - Legal provisions;
  - Government, Business Associations and Trade Unions.
  - Civil Society and NGOs;
  -

International Labor Organization (ILO):

- Creation of ILO: 1919.
- Objectives: to promote social justice as a contribution to universal and lasting peace.
- Preamble declaration of Constitution: "the protection of the worker against sickness, disease and injury arising out of employment" is a fundamental element of social justice.
- Reaffirmation of declaration: Right to decent, safe and healthy working conditions and environment has been reaffirmed in the 1944 Declaration of Philadelphia and the ILO Declaration on Social Justice for a Fair Globalization.
- Achievements: A significant body of international instruments has been developed by the ILO in the area of OSH over the past 90 years.
- About 80 per cent of all ILO standards and instruments are either wholly or partly concerned with issues related to OSH.

Most important ILO instruments are:

- the Occupational Safety and Health Convention, 1981 (No. 155), and its Recommendation, 1981 (No. 164),
- the Protocol of 2002 to Convention No. 155;
- the Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187), and its Recommendation (No. 197).

Country specific obligations:

- The Constitution of Bangladesh: acknowledge the right of working people.
- Bangladesh Labor Law: legally binding provisions for work place health and safety.

- OHS related laws and rules:
  - Labor laws 2006 amended up to 2013
  - Labor Rules 2015
  - National Occupational Health and Safety Policy 2013;
  - Bangladesh labor welfare foundation rules 2015

Benefits of OHS;

- The statement of the EU Community strategy 2007-2012 on health and safety at work confirms the interaction between health and safety at work on the one hand and productivity on the other hand (ILO, 2009).
- European Agency for Safety and Health stated that poor health and safety is linked to the low productivity and profitability (Peter Gahan et al, 2014).
- European Association for National Productivity Centres in its 'The High Road to Wealth' acknowledged productivity from the perspective of value creation where health and safety at work is one of the important factors (Hesapro, 2013).
- Fernandez et al found a positive impact of comprehensive WHS management with safety performance, competitiveness and financial performance (Fernandez et al, 2009, in Peter Gahan et al, 2014, p-19).
- A Finish Study shows that maintaining good OHS in SMEs bring economic benefits those include higher productivity, greater business continuity, less compensation payment and improved employee motivation (Ahonen, 1998 in Gervais et al, 2009)
- Health promotion program bring benefit to business through increasing productivity, reducing absenteeism and reduced life Insurance claims (Golaszewski, Snow, Lynch, Yen and Solomita, 1992 in Gervais et al, 2009).

2.1.6 Lean and Productivity

N.B For more detail, refer to file Module-Lean in Intervention/Training folder

- What is lean and lean philosophy: The core idea of Lean is to maximize customer value while minimizing waste. Simply, lean means creating more value for customers with fewer resources.A lean organization understands customer value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste. To accomplish this, lean thinking changes the focus of management from optimizing separate technologies, assets, and vertical departments to optimizing the flow of products and services through entire value streams that flow horizontally across technologies, assets, and departments to customers.

Eliminating waste along entire value streams, instead of at isolated points, creates processes that need less human effort, less space, less capital, and less time to make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to

respond to changing customer desires with high variety, high quality, low cost, and with very fast throughput times. Also, information management becomes much simpler and more accurate.

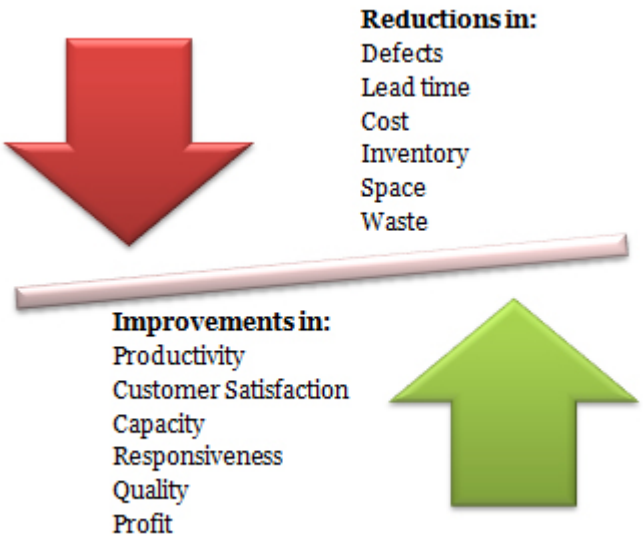


Fig: Lean philosophy

- Why lean is important: To help an organization survive for the long-term, as it faces new competition and changing macroeconomic conditions. Lean, done right, makes an organization more flexible and adaptable to change as it occurs. Survival gives an organization the continuing opportunity to better serve its customers over time. Good performance is relative. Most organizations process material information using the batch-and-queue method. If that's all you compete against, then performance can appear to be good. Customers expect great, not good, performance. If we are truly customer focused, then the reason we do Lean is to better satisfy customers. But there is more to it than that. Lean management is a better way to deal with low economic growth, which we may face for some time to come. Process improvement pays for things that an organization needs or what it must do for its stakeholders. The payoff will be low and slow if leaders fail to recognize Lean as a solution to information flow problems, and which also has the knock-on effect of improving human health in organizations. For an organization to reap the benefits of Lean, leaders have to admit all work processes can be improved, and that nobody is exempt from improvement. An organization where everyone improves their work processes, top to bottom, in non-zero-sum (win-win) ways, is one that progresses and will survive and prosper for the long-term.

- What are the tools of lean: There are several tools for lean technique. They are-
    - VSM: It stands for value stream mapping. Value stream mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer.
    - Time and motion study: A time and motion studyis an efficiency technique combining the Time Study work with the Motion Study work. Time study is a direct and continuous observation of a task, using a timekeeping device to record the time taken to accomplish a task and the motion study is the analysis of work motions', consisting in part of filming the details of a worker's activities and their body posture while recording the time.
    - SOP:A SOP is a procedure specific to your operation that describes the activities necessary to complete tasks in accordance with standards of the company. Any document that is a "how to" falls into the category of procedures.
    - 5S:
    - Lean flow
    - Kaizen
  - Process of lean implementation at management level;
  - Management involvement in lean implementation.
  - Integration of Lean with OHS

Appendix 5: KPI measurements

N.B For more detail, refer to files "Diagnosis tools for lean" (excel), "Time study training" (pdf), and VSM (excel) in Intervention/Training folder

Productivity KPIs

The suggestions for the productivity KPIs are mainly taken from P Sarkar's Garment Maker's Key Performance Indicators (2016).

The following productivity KPIs have been selected as they give a broad based introduction to the productivity of the line and thus lends itself clearly to identifying waste and improvements conditions as stipulated by the Lean method:

- Line efficiency - See Ref 4. Dropbox/Intervention
- Man to machine ratio- See Ref. 4 and 11. Dropbox/Intervention
- Right first time quality/Quality performance (DHU) - See Ref 5. Dropbox/Intervention
- Labor productivity (varies for department types) - See Ref 11. Dropbox/Intervention
- Changeover time- See Ref 11. Dropbox/Intervention

Line efficiency

The starting point for understanding the basic performance of the intervention company comes from calculating the line efficiency, as the line efficiency tells you how efficient a line is.

Line efficiency is calculated as:

Line efficiency = (line output x garment SAM)/(No. of operators x working hours daily x 60)

(See page 10 in Sarkar for details).

Ideally we get numbers for several lines and a duration, if the company has the number. If not, we need to ask them to provide us with the numbers for a 'normal week'. It is interesting to get both the average line efficiency and the variance between lines and lines across time (most likely we cannot get other lines than ours).

Man Machine ratio

Man Machine Ratio (MMR) is a natural follow up and is defined as '... number of total manpower per sewing machine' (Sarkar, p. 11). This gives a good indication of the waste in the utilization capacity of the machines and thereby waste of capacity. Again, this should be done on line level. Numbers for a 'normal week' is most likely needed, if the factory cannot provide valid numbers.

It is calculated as

MMR = total manpower/total number of utilized machines (see page 11). It should be adjusted to the different parts of the factory/types of lines e.g. : MMR sewing floor line = line manpower/total numbers of machines utilized at the line.

Quality: Right first time

Another waste is the time spend before the quality level is reached – Right first time (RFT) - as the company needs to do rework on the product is the quality is to low (e.g. fix or throw out). It thus has a positive effect on repair and rejection costs as well as on quality, on time delivery and productivity. This should be on line level.

RFT = (Total number of good pieces/number of pieces) x 100 (on line level).

Quality performance refers to the costs derived from the difference between actual quality and a zero mistake quality performance. This is often captured in DHU (defects per hundred) and percentage defects level (PDL) at the lines.

DHU is the number of defects per 100; DHU = (Total defects found/total pieces checked) X 100 (at the line).

PDL is the number of defectives per 100; PDL = (Total defectives found/total pieces checked) X 100 (at the line).

Defects refer to pieces not acceptable to the customer and defectives refer to one or more defects.

Labour productivity

The utilization of the man power is calculated as labour productivity (LP) in a line in the sewing department.

LP = line output (in pieces)/number of total labour worked (at line level).

Labour costs per minutes. It is measured as

Labour Cost per Minute = Total available minutes in a month/Total cost incurred in labour wages (in a sewing line) and as Labour cost per piece= Salary given to cutting department in a month /Total pieces cut in the month in cutting.

Machine productivity (MP) refers to the capacity utilization of the machines and points to the limited utilization of the capacity of the machines.

MP = line output (pieces)/total number of eg. sewing machines used in the line

Marker efficiency% = (Area of marker used for garments/ Total area of marker) x 100. This is the ratio of net fabric used on the marker to total available fabric laid.

Fabric Utilization% = (Weight of garment pattern area / Weight of total lay) x 100

Style changeover time (SCT) over refers to the ‘down time’ where the resources are not used, and thereby a waste.

It is calculated as: SCT = (Last piece out time of previous style– first piece out time of current style)

OHS KPIs and assessment

It is important to have all the data measured at the workstation and production line level (it is not the whole factory data)

A – OHS Quantitative KPI (line level) – The unit is number

1- Absenteeism
2- Accidents (Injuries)
3- Occupational sickness
4- Employee turn over (Migration)

Absenteism and turnover

Operator absenteeism at the level of the line gives an indicator of unneeded costs (if the absenteeism to some degree is a function eg. poor working conditions).

Absenteeism % = (No. of total absentees/ No. of total manpower planned for the day) x 100 at line level. Most likely they do not have good numbers and hence a 'normal week' needs to be established.

Employee turnover rate at line level (if possible) as it gives an unneeded cost (due to unneeded training costs and lower productivity in the beginning).

Emp. Turnover% = (No. of total employees left/(No. of emp. at start + No. of Emp. at end)/2) x 100

B- Measuring equipments (Workstation level)

- Temperature and humidity
- Light
- Noise

C- Research team assessment of ergonomics and workplace

N.B. For more details, see questionnaire in Appendix 7

C.1-Ergonomics (Workstation level) - The unit is categorical: Acceptable or Non acceptable

1- Head position
2- Arms position
3- Back position
4- Legs position

C.2- Workplace assessment (Workstation level) - The unit is categorical: Acceptable or Non acceptable

1- Machines, tools and materials' (easy reach, enough space, good maintenance, machine safety like needle protection)
2- Transport (containers easy access, manual lifting versus heavy lifting)
3- Housekeeping (clean and clear)
4- Vapour, Dust
5- Repetition of task (short cycle and monotonous tasks)

D- Workers OHS and participation assessment (see questionnaire in Appendix 7)

Appendix 6: Lean and OHS tools

N.B For more detail, refer to file Module-Lean in Intervention/Training folder

This document contains the description of the following lean and OHS tools:

Lean Tools:

- VSM (Responsible: Abu Hamja)
- Time and motion study (Responsible: Shams)
- SOP (Responsible: Malek)
- 5S (responsible: Shams)
- Lean flow (Responsible: Malek)
- Kaizen (Responsible: Abu)

OHS Tools:

- Materials storage and handling i.e. heavy material, lifting equipment (Responsible: Malek)
- Hand tools i.e. cutting and iron (Responsible: Abu)
- Machine safety i.e. finger protection and needle guards (Responsible: Shams)
- Workstation design i.e. tables and chairs (Responsible: Shams)
- Lighting (Responsible: Abu)
- Premises i.e. shop floor marking and safety (Responsible: Abu)
- Hazardous substances and agents (Responsible: Malek)
- Work organization i.e. job rotation and multiskilling (Responsible: Malek)

Value Stream Mapping (VSM)

Value stream mapping (VSM) is a tool used to visually indicate all actions required to bring a product in logical steps from start to finish. The purpose of value stream map is to understand the value flow.

Value stream mapping is a technique or tool with a pencil and paper that helps people to see and understand the flow of material and information as a product makes its way through the value stream. The elements of VSM include customer loop, production control, supplier loop, manufacturer loop, information flow, and lead time data bar with critical path that make us have a full view of the whole supply chain from customers' requirements to supplier's delivery.

Value stream mapping helps us understand where we are (current state), where we want to go (future state) and map a route to get there (Implementation plan), which can create a high level look at total efficiency, not the independent efficiencies of individual works or departments, visually show three flows- material flow, product flow, information flow to identify improvement opportunity, and help identify applicable lean improvement tools and plan for deployment. The practice of enterprises has successfully implemented lean production prove that VSM can eliminate 50% waste process/steps,

shorten cycle time by 30%, reduce variation from 30% to 5% and improve product quality greatly. So, we should implement lean production from VSM.

A VSM graphically shows followings:

- Each process or activity
- Inventory or queues between steps
- Set up time and cycle time
- Time line for the whole value stream
- Picture of the whole process
- Change needed to be implemented

Steps to preparing the VSM:

- Understand the status and prepare the current state map: Preparing the current map helps in communication, understand the existing state and understand the task required for new process.
- Collect the data: The following data must be collected for all the process from the manufacturing area
    - Cycle time: The time that elapses between one part coming off the process and the next part coming in
    - Changeover time: the time to switch from producing one product type to another
    - Available work time: The amount of work time available per shift in each process
    - Uptime: The amount of time in which the machine is ruining
    - Value added time: the time spent in transforming the product in a way that the customer willing to pay for.
    - Lead time: The time for taken for one piece to travel through the entire value stream from start to finish.
    - CD: Customer demand in quantity per month
- Arrange data in an information table
- Map the current production process
- Analyze the map:
    - Identifying the value added and non-value added activities
    - Understand customer requirement
    - Compute the takt time
    - Balance the line
    - Make a future state drawing

Steps to apply VSM:

The following Five steps can be used to apply VSM

Step 1: Identify product families

Usually, an enterprise manufactures products different volume and Varity according to business environment.

So, first step is to identify product families by matrix methods, namely, to classify products into different product families according to formula, which is the basis for applying VSM. Generally, total work content for producing one part should be within 25 to 30 percent (range) of all other different parts in one product family.

(Highest value- Lowest value)/Highest value

Example:

(20-10)/20= 50% (Out of range)

(14-10)/14= 29% (Within range)

Step 2. Analyze business to prioritize product families and selected one to Implement LM

After identifying product families, we should prioritize them according to their size, share of the business contribution to the net profit, criticality for the business, market position, technology, outlook, potential for gainful growth, expected impact from lean and resource requirements etc. Then we select a product line at a time to implement lean production according to the prioritization.

Step 3: Draw current state map of selected product line and analyze the whole process for improvement

We should walk the process on the spot to gather first-hand and practical information required for a good VSM and effective deployment of lean production, by doing so we can avoid fighting only on paper. Then we ask questions on each element of VSM and being to draw current state map with a pencil and pieces of paper from the customer, the shipping end, and work upstream through the process. The bursts in the figure show the process need to improve.

Step 4: Draw the future state map

The bursts in current state map shows us improvement direction, so we need to prepare for the future state map. We summarize several principals practically used for drawing future state map.

- Combine process steps

Lean production needs processes done in one activity by one person in one place, or even better, at one time with no human intervention. We should be "reluctant" in adding activities and resources to the process. When design a process so one person can move through it and efficiently perform all the work elements, we should combine process steps by avoiding isolated islands of activity, minimizing material and information between processes, eliminating excessive walking, therefore to reduce cycle and total lead time.

- Adopt continuous flow to build speed

Continuous flow manufacturing (CFM) means processes flow smoothly through all operation without stopping.

- Think parallel not linear layout

When study the layout of a production line, we should consider building it in parallel to realize make one move one that save space and eliminate waste of operators unwanted walking.

- Reduce resource of variation by 6 sigma management

6sigma management has gotten great success in many well-known companies such as GE and Motorola. We suggest adoption DMAIC (Define, measure, analyze, improve and control) method of six sigma management to eliminate waste associated with adding spare capacity and contingency in to processes to reduce variation and improve process efficiency.

- Re-design a process

Re-design a process for a future state map requires participants who can step back and look at the process with a fresh set of eyes. And ask, ourselves how we would design this process if it had no restrictions. We need to be visionary, system level thinkers that can see the total flow as it cuts across functional boundaries. Most often, these are management type, with no direct connection with the current process.

Step 5. Implementation future state

If you don't make great effort to realize future state, the map is meaningless at all. We propose steps for an enterprise to implement future step designedly.

1. Prioritize the Kaizen "bursts" on the future state map:

We should invite all the stake holders including all functions, all levels, all concerned shop floor employees to discuss which tool are required to achieve the goals for each loop and estimate the benefits and implementation costs of all the opportunities, and prioritize by rating them from 1 to 5 with 5 being the most important in consideration of necessary skills, availability of potential resources and the thoughts of plant management on the identified opportunities.

2. Develop master plan

We need to develop a master plan for the improvement with higher prioritization and put it in practice as a project including scope/strategy, work breakdown structure, activity list in logical order, required durations and dependencies, resource requirement, risk analysis, training needs and plans, performance measures to be impacted, goals and communication plan. Level of details should be proportional to the scope and benefits.

3. Develop metrics

We should set performance metrics to review if the goals of improvement are realized. When identify performance metrics, we should keep them simple that means understandable for all and link lean(shoop-floor) measures to the plant level measures and goal (Strategy). It is more important that lean measures must be reviewed regularly to check if they are suitable for Kaizen and therefore to promote and enterprise and its employees to make progress continuously , which is the core thinking of lean production.

4. Monitoring the implementation

Value stream manager should be in charge of monitoring the implementation of the plan with active participation of plant staff managers. They should identify a systematic process and structure for

reporting progress, issues and needs, and integrate monitoring with their normal business processes such as staff meeting, quality council meetings, daily production meetings. The objective of monitoring is to make lean production on the way and obtain continuous improvement.

5. Communications

We should employ all possible means especially visual means to take all the information easy to understand and accessible to all; encourage internal communication on the objectives , goals and approaches before starting; facilitate communication of periodic progress, broadcast the success loudly to all, communication failures and the lessons learned.

The means usually used for communication include;

- Meeting including plant-wide meetings, departmental meetings, council meetings, team meetings etc.
- Newsletter, regular sports, special bulletins, etc.
- Visual display of updates on individual product lines/ lean tool event (VSM, TPM,5S etc.)
- Visual display of all the information related to standardized work, cell layout, Kanban,etc.
- Real time visual display of production rate and goals
- Real time visual display of potential of problem or existing problems.

Motion and Time Study

- Motion and time study can reduce and control costs, improve working conditions and environment, and motivate people.

- The basic purpose is to improve the work and to reduce waste.

    1. Motion analysis techniques
    2. Time study techniques

    3. Uses of time standards.

- Manufacturing management and engineering students are being prepared to design work stations, develop efficient and effective work methods, establish time standards, balance assembly lines, estimate labor costs, develop effective tooling, select proper equipment, and layout manufacturing facilities.

- However, the most important thing is to learn how to train production workers in these skills and techniques so they can become motion and time conscious.
- Motion study offers a great potential for savings in any area of human effort. We can reduce the cost by combining elements of one task with elements of another.

- Motion study uses the principles of motion economy to develop work stations that are friendly to the human body and efficient in their operation.

- Motion study must consider the operator's safety

- Time study can reduce cost significantly well. Time standards are goals to strive for. In organizations that operate without time standards, 60% performance is typical.

- When time standards are set, performance improves to an average of 85%. This is a 42% increase in performance:

$$\frac{85\% - 60\%}{60\%} = 42\% \text{ performance increase.}$$

- Incentive systems can improve performance even further.

- Incentive system performances average 120%, that is another 42% increase in performance:

$$\frac{120\% - 85\%}{85\%} = 42\% \text{ performance increase.}$$

  - Manufacturing plants with no standards average 60% performance.
  - Manufacturing plants with time standards average 85% performance.
  - Manufacturing plants with incentive systems average 120% performance.

- If additional production output is required, don't buy more machinery, don't add a second shift, and don't build a new plant.

- Just establish a motion and time study program.

- Motion and time study is considered to be the backbone of industrial engineering, industrial technology, and industrial management programs because the information that time studies generate affects so many other areas, including the following:

    1. Cost estimating
    2. Production and inventory control
    3. Plant layout
    4. Materials and processes
    5. Quality
    6. Safety

- Motion study comes first before the setting of time standards. Motion study is a detailed analysis of the work method in an effort to improve it.

- Motion studies are used to

    1. Develop the best work method.
    2. Develop motion consciousness on the part of all employees.
    3. Develop economical and efficient tools, fixtures, & production aids.
    4. Assist in the selection of new machines and equipment.

5. Train new employees in the preferred method.
6. Reduce effort and cost.

- Motion study is for cost reduction, and time study is for cost control. Motion study is the creative activity of motion and time study.
- Motion study is design, while time study is measurement.

- Once the importance of motion and time study is understood and accepted, the techniques of motion and time study are introduced.
  - Flow diagrams
  - Multi activity charts
  - Operation charts
  - Flow process charts
  - Process charts
  - Operations analysis chart
  - Work station design
  - Motion economy
  - Flow patterns
  - Predetermined time standards system (PTSS).

- The techniques of time study start with the last motion study technique, which shows the close relationship between motion study and time study. The techniques of time study are:

1. **Predetermined time standards system (PTSS)**
2. **Stopwatch time study**
3. **Standard data formula time standards**
4. **Work sampling time standards**
5. **Expert opinion and historical data time standards.**

WHAT IS A MOTION STUDY?

- Motion studies are performed to eliminate waste. Before any improvement in quality or quantity of output, any study of operations time, any scheduling of work or balancing of workload or any calculation of standard time, a study of the current and proposed method is required.

- Studies of overall factory flow or process, called macro motion studies, and then additional studies of detail or operations, called micro motion studies, should be completed for a project.

- Motion studies were conducted by Frank and Lillian Gilbreth about a century ago in a search for the “one best way.” It is important to note that such studies seek to minimize and simplify manual efforts.

Macro motion Study

- Any process can be studied by dividing it into process activity. Although each activity is different, depending on the product, there are five classes of activities that are included in all processes. Savings, may be found in the process by reorganizing activities.

- These activities found in every sequence of processes are

Operations Changes in the properties of the product
Transportations Changes in the location of the product

Inspection	Confirmation that change fits to specification
Delay	Wait for start of operation, transportation, or inspection
Storage	Wait until needed

- When the process is first studied, each activity is recorded and arranged into one of the five classes. All observed activities are recorded, and activities not done are not recorded. The purpose of each activity should be studied.

- Typically, the questions Who? What? Where? When? Why? and How? must be answered. Next, each event is observed in the following sequence:

  Can the activity be eliminated? If not,
  Can the activity be combined and done with another activity? If not,
  Can the activity be rearranged so occur in the sequence at an easier time? If not.
  Can the activity be simplified with shorter distances, mechanical assist, or reduced complexity?

- Once these questions are asked and the improvement sequence is defined, it is necessary to draw a chart or diagram that shows the motion improvements.

Process Flow Plan	A plan-view plant layout with activities overlaid
Process Operations Chart	The sequence of serial and parallel operations
Process Chart	All serial activities on a preprinted form
Flow Process Chart	All serial and parallel activities on a single page
Work Cell Load Chart	A plan view with repetitive operations
Route Sheet	A planning tool for scheduling operations

Micro motion Study

- Considerable wasted motion and idle time can occur within an operation. This time can't be found with macro motion studies because is usually within one process operation. The improvement is gained from reducing the operation cycle time.

WHAT IS A TIME STANDARD?

- The definition of a time standard is "the time required to produce a product at a work station with the following three conditions:
  (1) a qualified, well-trained operator,
  (2) working at a normal pace,
  (3) doing a specific task."

- These three conditions are essential to the understanding of time study.

- The importance of time standards can be shown by the three statistics 60%, 85%, and 120% performance.

- The time standard is one of the most important pieces of information produced in the manufacturing department. It is used to develop answers for the following problems:
  – Determining the number of machine tools to buy
  – Determining the number of production people to employ
  – Determining manufacturing costs and selling prices
  – Scheduling the machines, operations, and people to do the job and deliver on time
  – Determining the assembly line balance, determining the conveyor belt speed, loading the work cells with the correct amount of work, and balancing the work cells
  – Determine individual worker performance and identifying operations that are having problems so the problems can be corrected
  – Paying incentive wages for outstanding team or individual performance
  – Evaluating cost reduction ideas and picking the most economical method based on cost analysis, not opinion
  – Evaluating new equipment purchases to justify their expense
  – Developing operation personnel budgets to measure management performance.

How would you answer the following questions without time standards?

How Many Machines Do We Need?

- One of the first questions arose when setting up a new operation or starting production on a new product is "how many machines do we need?" The answer depends on two pieces of information:
  a. How many pieces do we need to manufacture per shift?
  b. How much time does it take to make one part? (Time standard)

EXAMPLE

1. The marketing department wants us to make 2,000 wagons per 8-hour shift.
2. It takes us 0.400 minutes to form the wagon body on a press.
3. There are 480 minutes per shift (8 hours/shift x 60 minutes/hr).
4. - 50 minutes downtime per shift (breaks, clean-up, etc.)
5. There are 430 minutes per shift available @ 100%.
6. @ 75% performance (based on history) (0.75 x 430 = 322.5).
7. There are 322.5 effective minutes left to produce 2,000 units.

$$\frac{322.5}{2{,}000} = 0.161$$

minutes per unit, or 6.21 parts per minute.

- The 0.161 minutes per unit is plant rate. Every operation in the plant must produce a part every 0.161 minutes; therefore, how many machines do we need for this operation?

$$\frac{\text{Time standard} = 0.400 \text{ minutes/unit}}{\text{Plant rate} = 0.161 \text{ minutes/unit}} = 2.48 \text{ machines}$$

- This operation requires 2.48 machines. If other operations are required for this kind of machine, we would add all the machine requirements together and round up to the next whole number.
- In this example, we would buy three machines. (Never round down on your own. You will be building a bottleneck in your plant.)

How Many people should we hire?

- Look at the operations chart shown in Figure 4-1.
- From a study of this chart, we find the time standard (or every operation required to fabricate each part of the product and each assembly operation required to assemble and pack the finished product.
- In the operation shown here (casting the handle), the 05 indicates the operation number. Usually, 05 is the first operation of each part. The 500 is the pieces per hour standard. This operator should produce 500 pieces per hour. The 2.0 is the hours required to produce 1,000 pieces. At 500 pieces per hour, it would take us 2 hours to make 1,000. How many people would be required to cast 2,000 handles per shift

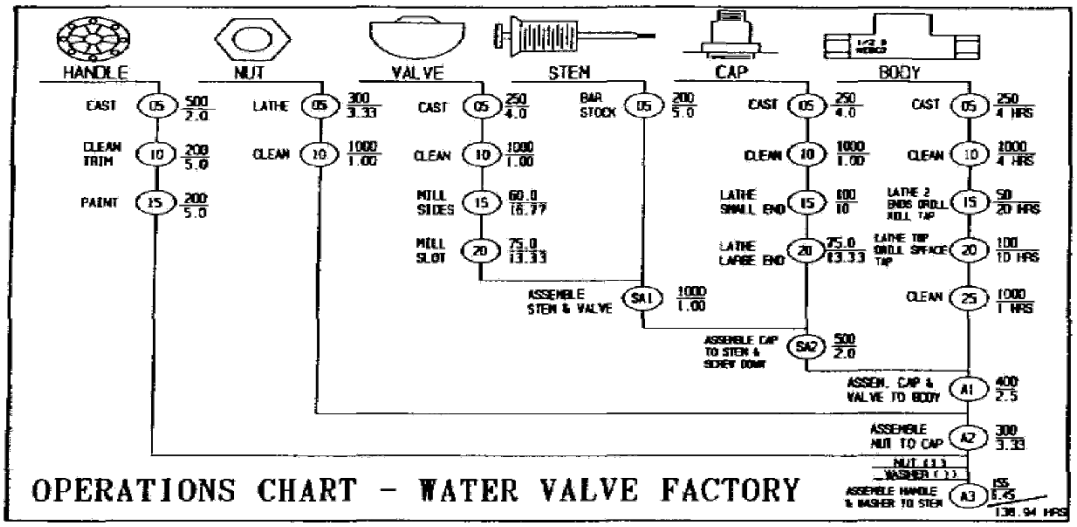
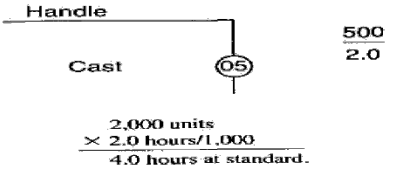


FIGURE 4-1 Operations chart for a water valve factory: A circle for every fabrication, assembly, and packout operation.



Not many people, departments, or plants work at 100% performance.
How many hours would be required if we work at the rate of 60%, 85%, or 120%?

4 hours
4 hours

4 hours
---------- = 6.66 hours; 60%
---------- = 4.7 hours;
85%
---------- = 3.33 hours.
120%

•Look again it use operations chart shown in Figure 4-1. Note the total 138.94 hours at the bottom right side. The operations chart includes every operation required to fabricate, paint, inspect, assemble, and pack out a product. The total hours is the total time required to make 1,000 finished products?

•In our water valve factory, we need 138.94 hours at 100% to produce 1,000 water valves. If this is a new product, we could expect 75% performance during the first year of production. Therefore,

138.94 hours per 1,000
---------- = 185 hours/1,000 where 75% =
0.75 75% performance

•The marketing department has forecasted sales of 2,500 water valves per day. How many people are needed to make water valves?

185 hours/1,000 X 2.5 (1,000) = 463 hours/day needed.

463 / 8 = 57.87 which is equal to 58 people.

•Management will be judged by how well it performs to this goal.

•If less than 2,500 units are produced per day with the 58 people, management will be over budget, and that is not good.

•If it produces more than 2,500 units per day, management is judged as being good at managing, and the managers are promotable.

•For example, how many direct labor employees do we need for a multi-product plant? Per day, 1,132 hours of direct labor are needed. Each employee will work 8 hours; therefore,

PRODUCT	HOURS/1,000	NO. OF UNITS NEEDED/DAY	HOURS AT 100%	ACTUAL %	ACTUAL HOURS NEEDED
A	150	1,000	150.0	70	214
B	95	1,500	142.5	85	168
C	450	2,000	900.0	120	750
					Total 1,132 hours

$$\frac{1{,}132 \text{ hours}}{8 \text{ hours/employee}} = 141.5 \text{ employees.}$$

We will hire 142 employees, and management will be evaluated on the performance of these 142 employees. Without time standards, how many employees would you hire?

Standard Operating Procedure (SOP)

A SOP is a procedure specific to your operation that describes the activities necessary to complete tasks in accordance with standards of the company. Any document that is a "how to" falls into the category of procedures. In a manufacturing environment, the most obvious example of an SOP is the step by step production line procedures used to make products as well train staff. A SOP, in fact, defines expected practices in all businesses where quality standards exist.

SOPs are policies, procedures and standards you need in the operations, marketing and administration disciplines within your business to ensure success. These can create: efficiencies, and therefore profitability, consistency and reliability in production and service, fewer errors in all areas, and a healthy and safe environment and protection for workers. Developing an SOP is about systemizing all of your processes and documenting them. Every business has a unique market, every entrepreneur has his/her own leadership style, and every industry has its own best practices. No two businesses will have an identical collection of SOPs.

A SOP is a compulsory instruction. If deviations from this instruction are allowed, the conditions for these should be documented including who can give permission for this and what exactly the complete procedure will be. The original should rest at a secure place while working copies should be authenticated with stamps and/or signatures of authorized persons.

Several categories and types of SOPs can be distinguished. A number of important SOP types are:

- SOPs for safety precautions
- Standard operations routine: is the order of actions that each worker must perform
- Standard procedures for operating instruments, apparatus and other equipment
- SOPs for receiving and registration of samples
- SOPs for Quality Assurance
- Fundamental SOPs. These give instructions how to make SOPs of the other categories

Tips

- Develop procedures in the language, style and format best for the establishment (the garment industry/operations knowledge is crucial here)
- Write SOPs in clear, concise language so that processes and activities occur as they are supposed to
- The level of detail in SOPs should provide adequate information to keep performance consistent while keeping the procedures from becoming impractical

- Keep written SOPs on-site so that they can be used by supervisors and employees
- Drafts should be made and tested before a SOP is released for implementation

Initiating a SOP

As implied above, the initiative and further procedure for the preparation, implementation and management of the documents is a procedure in itself which should be described. These SOPs should at least mention:

a) who can or should make which type of SOP
b) to whom proposals for a SOP should be submitted, and who adjudges the draft
c) the procedure of approval
d) who decides on the date of implementation, and who should be informed
e) how revisions can be made or how a SOP can be withdrawn

It should be established and recorded who is responsible for the proper distribution of the documents, the filing and administration (e.g. of the original and further copies). Finally, it should be indicated how frequently a valid SOP should be periodically evaluated (usually 2 years) and by whom. Only officially issued copies may be used, only then the use of the proper instruction is guaranteed.

Preparation of SOPs

The make-up of the documents should meet a minimum number of requirements:

Each page should have a heading and/or footing mentioning:

a) date of approval and/or version number
b) a unique title (abbreviated if desired)
c) the number of the SOP (preferably with category)
d) page number and total number of pages of the SOP
e) the heading (or only the logo) of originals should preferably be printed in another colour than black
f) Categories can be denoted with a letter or combination of letters

The first page, the title page, should mention:

a) general information mentioned under 2.3.1 above, including the complete title;
b) a summary of the contents with purpose and field of application (if these are not evident from the title) if desired the principle may be given, including a list of points that may need attention
c) any related SOPs (of operations used in the present SOP)
d) possible safety instructions
e) name and signature of author, including date of signing. (It is possible to record the authors centrally in a register)
f) name and signature of person who authorizes the introduction of the SOP (including date)
g) The necessary equipment, reagents (including grade) and other means should be detailed
h) A clear, unambiguous imperative description is given in a language mastered by the user.
i) It is recommended to include criteria for the control of the described system during operation.

j) It is recommended to include a list of contents particularly if the SOP is lengthy.
k) It is recommended to include a list of references.

Administration, Distribution, Implementation

From this description it would seem that the preparation and administration of a SOP and other quality assurance documentation is an onerous job. However, once the draft is made, with the use of word processors and a simple distribution scheme of persons and departments involved, the task can be considerably eased.

There is a multitude of valid approaches for distribution of SOPs but there must always be a mechanism for informing potential users that a new SOP has been written or that an existing SOP has been revised or withdrawn. It is worthwhile to set up a good filing system for all documents right at the outset. This will spare much inconvenience, confusion and embarrassment, not only in internal use but also with respect to the institute's management, authorities, clients and, if applicable, inspectors of the accreditation body.

The data which should be stored per document are:

- SOP number
- version number
- date of issue
- date of expiry
- title
- author
- status (title submitted; being drafted; draft ready; issued)
- department of holders/users
- names of holders
- number of copies per holder if this is more than one
- registration number of SOPs to which reference is made
- historical data (dates of previous issues)

The SOP administrator keeps at least two copies of each SOP; one for the historical and one for the back-up file. This also applies to revised versions. Superseded versions should be collected and destroyed (except the copy for the historical file) to avoid confusion and unauthorized use.

5S

While some Lean Six Sigma (LSS) practitioners consider 5S a tool, it is more than that. 5S, abbreviated from the Japanese words seiri, seito, seiso, seiketsu, shitsuke, is not just a methodology, it is a culture that has to be built in to any organization which aims for spontaneous and continuous improvement of working environment and working conditions. It involves everyone in the organization from the top level to bottom. The Japanese developed this simple and easily understandable words religiously practiced the philosophy of 5S at every aspect of their life and have made it a worldwide recognizable system.

Too often in LSS the 5S philosophy is confined to one classroom training session or, at best, used as a one-time implementation methodology that then dies its own death due to negligence. 5S is not a list of action items that has to be reviewed at some interval of time. Instead, it has to be practiced as a daily activity, which requires concentration, dedication and devotion for sustaining it and ultimately making it a company-wide culture.

A proper and step-by-step process has to be followed to make 5S a practice and a success.

Plan-Do-Check-Act Approach to 5S

The PDCA (plan, do, check, act), or "Deming cycle," of implementing 5S is effective. This is a never-ending process and has to follow a process approach.

Step 1: Seiri, or Sort

Seiri is sorting through the contents of the workplace and removing unnecessary items. This is an action to identify and eliminate all unnecessary items from the workplace.

Actions items:

1. Look around the workplace along with colleagues to discover and identify items which are not needed and not necessary to complete work.

2. Develop criteria for disposal for not-needed items.

3. Take "before" photographs wherever it is required.

4. An effective method for recording progress is to tag the items not needed. This visual control of the not-needed items is often called red tagging.

5. While red tagging, ask these questions:

- Is this item needed?
- If it is needed, is it needed in this quantity?
- If it is needed, how frequently is it used?
- If it is needed, should it be located here?
- Who is ultimately responsible for the item? (Verify from that person.)
- Are there any other not-needed items cluttering the workplace?
- Are there tools or material left on the floor?

6. Find a holding area to put red tagged items.

7. If it is difficult to decide whether an item is necessary or not, put a different tag and segregate it in the holding area.

8. Classify the items by frequency of use.

9. Items or equipment used hour by hour or day by day should be kept within arm's reach of the point of use.

10. Items or equipment used once a week or once a month should be kept within the work area.

11. Items or equipment used less frequently should be stored in a more distant location.

12. Unneeded or unnecessary items should be stored in the holding area.

13. Individual departments should each have a holding area.

14. A holding area should be clearly visible and clearly marked to assure visual control of items.

15. Display pictures of items and place it on a public board visible to all.

16. Responsibility for the holding area should be assigned to some at the beginning of sorting activity.

17. The items in holding area should be kept for three or four months. If the items are not needed for work, then the items can be disposed. It is always necessary to verify plans to dispose of items with anyone who had been using these items in the past or are presently using the same or similar type of items.

18. Items should be moved to a company-level holding area before final disposal of the items.

19. The facility manager or an authorized person has to evaluate the items.

20. Disposal should be done in either of the following ways.

- Move to other department/section where the items are required.
- Sell to someone outside the company.
- Discard and haul away.

21. Dispose all items which are broken or have no value.

22. Take "after" photographs wherever it is required.

Step 2: Seiton, or Systematize

Seiton is putting the necessary items in their place and providing easy access. This is an action to put every necessary item in good order, and focuses on efficient and effective storage methods.

Action items:

1. Make sure that all unnecessary items are eliminated from the workplace.

2. Taking into account of the work flow, decide which things to put where.

3. Take "before" photographs wherever necessary.

4. Also decide with colleagues about which things to put where from the point of view of efficient operations.

5. This should be done as per the frequency of use of items. More frequently used items should be kept near the workplace (see Nos. 9, 10 and 11 under Seiri).

6. Workers should answer these questions:

- What do I need to do my job?
- Where should I locate this item?
- How many of this item do I really need?

7. Make a plan based on the principles and locate things accordingly.

8. Use 5Whys to decide where each item belongs.

9. Locate needed items so they can be retrieved in 30 to 60 seconds with minimum steps.

10. Make sure to inform everybody at the workplace about positioning of the items.

11. Make a clear list of items with their locations and put it on lockers or cabinets.

12. Label each locker/drawer/cupboard to show what is kept inside.

13. Outline locations of equipment, supplies, common areas and safety zones with lines:

- Divider lines define aisle ways and work stations.
- Marker lines show position of equipment.
- Range lines indicate range of operation of doors or equipment.
- Limit lines show height limits related to items stored in the workplace.
- Tiger marks draw attention to safety hazards.
- Arrows show direction.

14. Identify all needed items with labels.

15. Take “after” photographs.

16. Complete evaluation using 5S levels of implementation with the facility manager or the authorized person in the organization.

Step 3: Seiso, or Sweep

Seiso involves cleaning everything, keeping it clean daily, and using cleaning to inspect the workplace and equipment for defects. This is an action to clean the workplace daily.

Actions items:

1. Take “before” photographs.

2. Adopt cleaning as a daily activity and as a part of inspection. Clean the workplace before starting of the job and before closing the job.

3. Put aside 10 or 15 minutes for the same activity per day.

4. Cleaning indirectly helps to check or inspect each and every part and place. Hence, it should be a habit.

5. Find ways to prevent dirt and contamination.

6. Clean both inside and outside on daily basis.

7. Identify and tag every item that causes contamination.

8. Use 5Whys or cause-and-effect methods to find the root causes of such contamination and take appropriate corrective and preventive action.

9. Keep a log of all places/areas to be improved. Table 1 shows a format for a log for cleaning improvements.

- Sample Log for Cleaning Improvements Questions
- WHERE is the problem located?
- WHAT exactly is the problem?
- WHO is responsible to take action?
- WHEN will solution be implemented?
- HOW is solution to be implemented?
- Answers (Use a much detail as needed)

10. 5S "owner" check-sheets should be maintained on daily basis. An example of a check sheet is illustrated in Table 2. (The word owner here is used as a replacement for the title of operator. An operator merely operates the machine or process, and might think cleaning is below them. An owner cares for the machine and area in which he or she works.)

5S Owner Check Sheet

Machine Number: Mon Tue Wed Thu Fri

Machine Name: 3/11 3/12 3/13 3/14 3/15

Machine Location:

No. Checks Frequency Initials of Person Responsible

1 Red tagging contaminated items Daily
2 Remove residue from valves Daily
3 Check oil level Every Tuesday
4 Apply grease to transfer side Every Thursday

Check Supervised by Bill Smith Daily

11. Develop a plan, activity chart and distribute responsibility.

12. Take “after” photographs.

13. In addition to 10 to 15 minutes for Seiso everyday, owners should have a weekly 5S time, or monthly 5S day.

14. Complete evaluation using 5S levels of implementation with the facility manager or the authorized persons in the organization.

Step 4: Seiketsu, or Standardize

Seiketsu involves creating visual controls and guidelines for keeping the workplace organized, orderly and clean. This is a condition where a high standard of good housekeeping is maintained. The first three steps, or S’s, are often executed by order. Seiketsu helps to turn it into natural, standard behavior.

Actions items:

1. Take “before” photographs.

2. Check that the first three S’s are implemented properly.

3. All team activity documents/check lists should be publicly displayed on a 5S board.

4. Establish the routines and standard practices for regularly and systematically repeating the first three S’s.

5. Create procedures and forms for regularly evaluating the status of the first three S’s.

6. Standardize red tag procedures and holding area rules (see Seiri).

7. Standardize procedures for creating shadow boards, position lines, and labeling of all items

(see Seiton).

8. Standardize cleaning schedules using the “5S Owner Check Sheets” (see Seiso).

9. Standardize “single-point lessons” for documenting and communicating 5S procedures and improvements in workplace and equipment.

10. Create a maintenance system for housekeeping. Make a schedule for cleaning of the workplace. A common approach is to ask a cross-functional team to do it.

11. Inter-departmental competition is an effective means of sustaining and enhancing interest in 5S.

12. Assign responsibility to individuals for a work area and machinery.

13. Regular inspection/audit and evaluation by a special team (including senior management persons) to be continued.

14. Instead of criticizing poor cases, praise and commend good practices or good performers.

15. Take “after” photographs and post them on the 5S board(s).

16. Complete evaluation using 5S levels of implementation with the facility manager or the authorized persons in the organization.

Step 5: Shitsuke, or Self-Discipline

Shitsuke involves training and discipline to ensure that everyone follows the 5S standards. This is a condition where all members practice the first four S’s spontaneously and willingly as a way of life. Accordingly, it becomes the culture in the organization.

Actions items:

1. Everyone in the workplace should treat it they would their own home.

2. Periodic facility management involvement is required to check that the first four S’s are implemented perfectly.

3. Employees must make it a part of their daily work and not an action forced upon them.

4. Dedication, commitment, devotion and sincerity are needed in implementation of 5S on daily basis.

5. Senior management should initiate a celebration for the total 5S implementation, and be an active part in the total process in initiating and carrying forward the program.

6. Senior management should do a periodic review of the status of 5S.

7. Inspections of first three S’s should be done and the results displayed on 5S board regularly.

8. Single point lessons should be used to communicate the standards for how 5S work should be done.

9. Root cause problem-solving process should be in place where root causes are eliminated and improvement actions include prevention.

10. Owners conduct 5S Kaizen activities and document results. Owners (operators) complete daily check sheets to control factors that accelerate deterioration of equipment, and to keep clean workplaces that help build pride.

When fully implemented, the 5S process increases morale, creates positive impressions on customers, and increase efficiency and organization. Not only will employees feel better about where they work, the effect on continuous improvement can lead to less waste, better quality and faster lead times. 5S is not only a system for housekeeping, it is an integrated approach for productivity improvement. 5S is a whole a culture which increases production, improves quality, reduces cost, makes delivery on

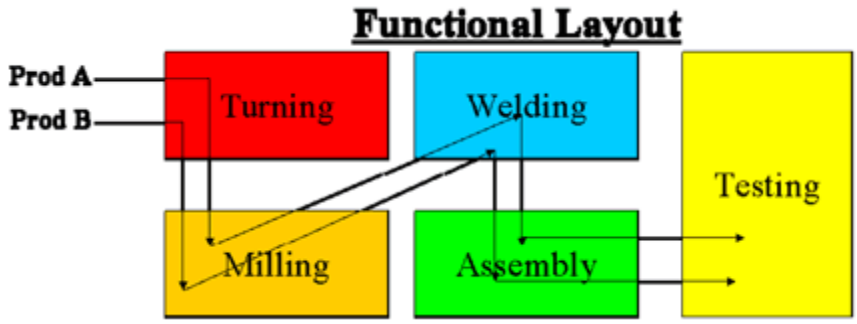
time, improves safety and improves morale. 5S also is not a list of action items, but is an integrated concept of actions, condition and culture. To get the greatest success, the nature and implication of each "S" need to be understood by each employee and should be regularly practiced.

Lean flow

It is also referred to as "single-piece flow" or "continuous flow," one-piece flow is a key concept within lean. Achieving one-piece flow helps manufacturers achieve true just-in-time manufacturing. That is, the right parts can be made available when they are needed in the quantity they are needed. In the simplest of terms, one-piece flow means that parts are moved through operations from step to step with no work-in-process (WIP) in between either one piece at a time or a small batch at a time. This system works best in combination with a cellular layout in which all necessary equipment is located within a cell in the sequence in which it is used.

One-piece flow is one of the key concepts within lean manufacturing; in most cases, a piece of a value stream can be transformed into a one-piece flow operation. While one-piece flow is not always achievable for an entire door-to-door value stream, manufacturers must continually improve their processes in an attempt to get closer and closer to true one piece flow. This will reduce inventory levels, reduce manufacturing lead time, and improve customer service levels.

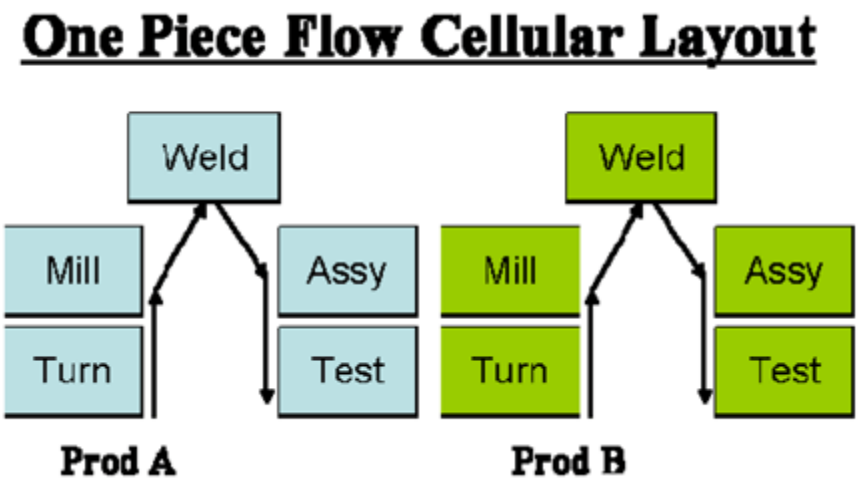
While many are familiar with the terminology, there is still a significant amount of confusion regarding what one-piece flow means and, more importantly, how to achieve it.



Let us begin by stepping back and attempting to understand the concept of "connected flow." Achieving connected flow means implementing a means of connecting each process step within a value stream. In a typical MRP batch-and-queue manufacturing environment as illustrated above, parts move from functional area to functional area in batches, and each processing step or set of processing steps is controlled independently by a schedule. There is little relationship between each manufacturing step and the steps immediately upstream or downstream. This results in:

- Large amounts of scrap when a defect is found because of large batches of WIP
- Long manufacturing lead time
- Poor on-time delivery and/or lots of finished goods inventory to compensate
- Large amounts of WIP

When we achieve connected flow, there is a relationship between processing steps: That relationship is either a pull system such as a supermarket or FIFO lane or a direct link (one-piece flow). As illustrated below, one-piece flow is the ideal method for creating connected flow because product is moved from step to step with essentially no waiting (zero WIP).



Why would we not always create one-piece flow for every set of processes within a value stream? To be good candidates for one-piece flow, we must have the following conditions:

- Processes must be able to consistently produce good product. If there are many quality issues, one-piece flow is impossible.
- Process times must be repeatable as well. If there is much variation, one-piece flow is impossible.
- Equipment must have very high (near 100 percent) uptime. Equipment must always be available to run. If equipment within a manufacturing cell is plagued with downtime, one-piece flow will be impossible.
- Processes must be able to be scaled to takt time, or the rate of customer demand. For example, if takt time is 10 minutes, processes should be able to scaled to run at one unit every 10 minutes.

Without the above conditions in place, some other form of connecting flow must be used. This means that there will be a buffer of inventory typically in the form of a supermarket or FIFO lane between processes; the goal would be to eventually achieve one-piece flow (no buffer) by improving the processes.

If a set of processes is determined to a candidate for one-piece flow, then the next step is to begin implementation of a one-piece flow cell.

The first step in implementing a one-piece flow cell is to decide which products or product families will go into the cells, and determine the type of cell: Product-focused or mixed model. For product focused cells to work correctly, demand needs to be high enough for an individual product. For mixed model cells to work, changeover times must be kept short; a general rule of thumb is that changeover time must be less than one takt time.

The next step is to calculate takt time for the set of products that will go into the cell. Takt time is a measure of customer demand expressed in units of time and is calculated as follows:

Takt time = Available work-time per shift / Customer demand per shift

Next, determine the work elements and time required for making one piece. In much detail, list each step and its associated time. Time each step separately several times and use the lowest repeatable time.
Then, determine if the equipment to be used within the cell can meet takt time. Considerations here include changeover times, load and unload times, and downtime.

The next step is to create a lean layout. Using the principles of 5-S (eliminating those items that are not needed and locating all items/equipment/materials that are needed at their points of use in the proper sequence), design a layout. Space between processes within a one-piece flow cell must be limited to eliminate motion waste and to prevent unwanted WIP accumulation. U-shaped cells are generally best; however, if this is impossible due to factory floor limitations, other shapes will do. For example, I have implemented S-shaped cells in areas were a large U-shape is physically impossible.

Finally, balance the cell and create standardized work for each operator within the cell. Determine how many operators are needed to meet takt time and then split the work between operators. Use the following equation:

Number of operators = Total work content / Takt time

In most cases, an “inconvenient” remainder term will result (e.g., you will end up with Number of Operators = 4.4 or 2.3 or 3.6 instead of 2.0, 3.0, or 4.0). If there is a remainder term, it may be necessary to kaizen the process and reduce the work content. Other possibilities include moving operations to the supplying process to balance the line. For example, one of my clients moved simple assembly operations from their assembly line to their injection molding operation to reduce work content and balance the line.

After implementation is complete, one-piece flow must be sustained through regular auditing of standardized work.

Kaizen

KAIZEN is a Japanese word which consist of two terms i.e.KAI means “CHANGE” and ZEN means “GOOD”. So, over all KAIZEN means “Changes done for better improvement in a management system of companies”. In simple manner KAIZEN means continuous improvement by including all members, Higher authorities, Managers, Workers and each and every one related to it with practical implementation of ideas.

Kaizen refers to a series of activities through which waste sources are eliminated one at a time, for minimal cost, by workers pooling their wisdom and understanding of the work, thus increasing efficiency in an effective timely manner.

The Principles of Kaizen are:

- Human resources are the most important company asset

- Process must evolve by gradual improvement rather than radical changes
- Improvement must be based on evaluation of process performance
- By practicing Kaizen culture, managers demonstrate commitment to quality. Also, the workers with adequate support from managers become a major source of improvement.
- Kaizen system is simple, but their implications are far reaching. These can be in the area of Productivity, Quality, Cost, Delivery, Safety & Morale of Employees i.e.; PQCDSM.
- It is continuous process.

Ten basic principles for improvement in the view of KAIZEN:

1. Throw outall of your fixed ideas about how to do things.
2. Think of how the new method willwork-not how it won't.
3. Don't accept excuses. Totally deny the status quo.
4. Don't seek perfection. A 50-percent implementation rate is fine as long as it's done on the spot.
5. Correct mistakes the moment they're found.
6. Don't spend a lot of money on improvement.
7. Problems give you a chance to use your brain.
8. Ask "why" at least five times until you find the ultimate cause.
9. Ten people's ideas are better than one person's.
10. Improvement knows no limit.

Purpose of Kaizen:

Kaizen activities focus on every operation and process in order to add value and eliminate waste.

Process: is the sequence of operations needed to design and make a product.

Operation: is one activity performed by a single machine or person on that product.

Target of Kaizen:

1. Products (Quantity, Rejects etc.)
2. Equipment (Changeover, Utilization, Breakdown)
3. Human (Communication, Awareness, Stillness)
4. Processes (Waiting Time, Bottleneck, Line Balancing, VCS)
5. System (QC, Specification, Infection)

OHS Tools

Definition of Occupational Health and Safety (OHS):

The science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment (ILO, 2009).

OHS is aimed to:

- Promote and maintain the highest degree of physical, mental and social well-being;
- Promotes better human resource management
- Motivate workers with a higher degree of job satisfaction
- Encourage to produce better-quality product and services.

Benefits of OHS;

- The statement of the EU Community strategy 2007-2012 on health and safety at work confirms the interaction between health and safety at work on the one hand and productivity on the other hand (ILO, 2009).
- European Agency for Safety and Health stated that poor health and safety is linked to the low productivity and profitability (Peter Gahan et al, 2014).
- European Association for National Productivity Centres in its 'The High Road to Wealth' acknowledged productivity from the perspective of value creation where health and safety at work is one of the important factors (Hesapro, 2013).
- Fernandez et al found a positive impact of comprehensive WHS management with safety performance, competitiveness and financial performance (Fernandez et al, 2009, in Peter Gahan et al, 2014, p-19).
- A Finish Study shows that maintaining good OHS in SMEs bring economic benefits those include higher productivity, greater business continuity, less compensation payment and improved employee motivation (Ahonen, 1998 in Gervais et al, 2009)

Health promotion program bring benefit to business through increasing productivity, reducing absenteeism and reduced life Insurance claims (Golaszewski, Snow, Lynch, Yen and Solomita, 1992 in Gervais et al, 2009)

OHS tools

- Materials storage and handling i.e. heavy material, lifting equipment (Responsible: Malek)
- Hand tools i.e. cutting and iron (Responsible: Abu)
- Machine safety i.e. finger protection and needle guards (Responsible: Shams)
- Workstation design i.e. tables and chairs (Responsible: Shams)
- Lighting (Responsible: Abu)
- Premises i.e. shop floor marking and safety (Responsible: Abu)
- Hazardous substances and agents (Responsible: Malek)
- Work organization i.e. job rotation and multiskilling (Responsible: Malek)

Materials handling

Handling and storing materials involve diverse operations such as hoisting tons of steel with a crane; driving a truck loaded with concrete blocks; carrying bags or materials manually; and stacking palletized bricks or other materials such as drums, barrels, kegs, and lumber.

The efficient handling and storing of materials are vital to industry. In addition to raw materials, these operations provide a continuous flow of parts and assemblies through the workplace and ensure that materials are available when needed. Unfortunately, the improper handling and storing of materials often result in costly injuries.

What should your employees know before moving, handling, and storing materials?

In addition to training and education, applying general safety principles—such as proper work practices, equipment, and controls—can help reduce workplace accidents involving the moving, handling, and storing of materials. Whether moving materials manually or mechanically, your employees should know and understand the potential hazards associated with the task at hand and how to control their workplaces to minimize the danger.

Because numerous injuries can result from improperly handling and storing materials, workers should also be aware of accidents that may result from the unsafe or improper handling of equipment as well as from improper work practices. In addition, workers should be able to recognize the methods for eliminating—or at least minimizing—the occurrence of such accidents. Employers and employees should examine their workplaces to detect any unsafe or unhealthful conditions, practices, or equipment and take corrective action.

What are the potential hazards for workers?

- Strains and sprains from lifting loads improperly or from carrying loads that are either too large or too heavy,
- Fractures and bruises caused by being struck by materials or by being caught in pinch points, and
- Cuts and bruises caused by falling materials that have been improperly stored or by incorrectly cutting ties or other securing devices.

What precautions should workers take when moving materials manually?

When moving materials manually, workers should attach handles or holders to loads. In addition, workers should always wear appropriate personal protective equipment and use proper lifting techniques. To prevent injury from oversize loads, workers should seek help in the following:

- When a load is so bulky that employees cannot properly grasp or lift it,
- When employees cannot see around or over a load, or
- When employees cannot safely handle a load.

Using the following personal protective equipment prevents needless injuries when manually moving materials:

- Hand and forearm protection, such as gloves, for loads with sharp or rough edges.
- Eye protection.
- Steel-toed safety shoes or boots.
- Metal, fiber, or plastic metatarsal guards to protect the instep area from impact or compression.

What precautions should workers take when moving materials mechanically?

Using mechanical equipment to move and store materials increases the potential for employee injuries. Workers must be aware of both manual handling safety concerns and safe equipment operating techniques. Employees should avoid overloading equipment when moving materials mechanically by letting the weight, size, and shape of the material being moved dictate the type of equipment used. All materials-handling equipment has rated capacities that determine the maximum weight the equipment can safely handle and the conditions under which it can handle that weight. Employers must ensure that the equipment-rated capacity is displayed on each piece of equipment and is not exceeded except for load testing.

Although workers may be knowledgeable about powered equipment, they should take precautions when stacking and storing material. When picking up items with a powered industrial truck, workers must do the following:

- Center the load on the forks as close to the mast as possible to minimize the potential for the truck tipping or the load falling,
- Avoid overloading a lift truck because it impairs control and causes tipping over,
- Do not place extra weight on the rear of a counterbalanced forklift to allow an overload,
- Adjust the load to the lowest position when traveling,
- Follow the truck manufacturer's operational requirements, and
- Pile and cross-tier all stacked loads correctly when possible.

What precautions must workers take to avoid storage hazards?

Stored materials must not create a hazard for employees. Employers should make workers aware of such factors as the materials' height and weight, how accessible the stored materials are to the user, and the condition of the containers where the materials are being stored when stacking and piling materials. To prevent creating hazards when storing materials, employers must do the following:

- Keep storage areas free from accumulated materials that cause tripping, fires, or explosions, or that may contribute to the harboring of rats and other pests;
- Place stored materials inside buildings that are under construction and at least 6 feet from hoist ways, or inside floor openings and at least 10 feet away from exterior walls;
- Separate noncompatible material; and
- Equip employees who work on stored grain in silos, hoppers, or tanks, with lifelines and safety belts.

In addition, workers should consider placing bound material on racks, and secure it by stacking, blocking, or interlocking to prevent it from sliding, falling, or collapsing.

What safeguards must workers follow when stacking materials?

Stacking materials can be dangerous if workers do not follow safety guidelines. Falling materials and collapsing loads can crush or pin workers, causing injuries or death. To help prevent injuries when stacking materials, workers must do the following:

- Stack lumber no more than 16 feet high if it is handled manually, and no more than 20 feet if using a forklift;
- Remove all nails from used lumber before stacking;
- Stack and level lumber on solidly supported bracing;
- Ensure that stacks are stable and self-supporting;
- Do not store pipes and bars in racks that face main aisles to avoid creating a hazard to passersby when removing supplies;
- Stack bags and bundles in interlocking rows to keep them secure; and
- Stack bagged material by stepping back the layers and cross-keying the bags at least every ten layers (to remove bags from the stack, start from the top row first).

During materials stacking activities, workers must also do the following:

- Store baled paper and rags inside a building no closer than 18 inches to the walls, partitions, or sprinkler heads;
- Band boxed materials or secure them with cross-ties or shrink plastic fiber;
- Stack drums, barrels, and kegs symmetrically;
- Block the bottom tiers of drums, barrels, and kegs to keep them from rolling if stored on their sides;
- Place planks, sheets of plywood dunnage, or pallets between each tier of drums, barrels, and kegs to make a firm, flat, stacking surface when stacking on end;
- Chock the bottom tier of drums, barrels, and kegs on each side to prevent shifting in either direction when stacking two or more tiers high; and
- Stack and block poles as well as structural steel, bar stock, and other cylindrical materials to prevent spreading or tilting unless they are in racks.

Important Safety Measures

To reduce the number of accidents associated with workplace equipment, employers must train employees in the proper use and limitations of the equipment they operate. In addition to powered industrial trucks, this includes knowing how to safely and effectively use equipment such as conveyors, cranes, and slings.

What safety measures should employer stake regarding conveyors?

When using conveyors, workers may get their hands caught in nip points where the conveyor medium runs near the frame or over support members or rollers. Workers also may be struck by material falling off the conveyor, or they may get caught in the conveyor and drawn into the conveyor path as a result. To prevent or reduce the severity of an injury, employers must take the following precautions to protect workers:

- Install an emergency button or pull cord designed to stop the conveyor at the employee's work station.
- Install emergency stop cables that extend the entire length of continuously accessible conveyor belts so that the cables can be accessed from any location along the conveyor.
- Design the emergency stop switch so that it must be reset before the conveyor can be restarted.

- Ensure that appropriate personnel inspect the conveyor and clear the stoppage before restarting a conveyor that has stopped due to an overload.
- Prohibit employees from riding on a materials-handling conveyor.
- Provide guards where conveyors pass over work areas or aisles to keep employees from being struck by falling material. (If the crossover is low enough for workers to run into it, mark the guard with a warning sign or paint it a bright color to protect employees.)
- Cover screw conveyors completely except at loading and discharging points. (At those points, guards must protect employees against contacting the moving screw. The guards are movable, and they must be interlocked to prevent conveyor movement when the guards are not in place.)

What safety measures should employer stake regarding cranes?

Employers must permit only thoroughly trained and competent workers to operate cranes. Operators should know what they are lifting and what it weighs. For example, the rated capacity of mobile cranes varies with the length of the boom and the boom radius. When a crane has a telescoping boom, a load may be safe to lift at a short boom length or a short boom radius, but may overload the crane when the boom is extended and the radius increases.

To reduce the severity of an injury, employers must take the following precautions:

- Equip all cranes that have adjustable booms with boom angle indicators.
- Provide cranes with telescoping booms with some means to determine boom lengths unless the load rating is independent of the boom length.
- Post load rating charts in the cab of cab-operated cranes. (All cranes do not have uniform capacities for the same boom length and radius in all directions around the chassis of the vehicle.)
- Require workers to always check the crane's load chart to ensure that the crane will not be overloaded by operating conditions.
- Instruct workers to plan lifts before starting them to ensure that they are safe.
- Tell workers to take additional precautions and exercise extra care when operating around power lines.
- Teach workers that outriggers on mobile cranes must rest on firm ground, on timbers, or be sufficiently cribbed to spread the weight of the crane and the load over a large enough area. (Some mobile cranes cannot operate with outriggers in the traveling position.)
- Direct workers to always keep hoisting chains and ropes free of kinks or twists and never wrapped around a load.
- Train workers to attach loads to the load hook by slings, fixtures, and other devices that have the capacity to support the load on the hook.
- Instruct workers to pad sharp edges of loads to prevent cutting slings.
- Teach workers to maintain proper sling angles so that slings are not loaded in excess of their capacity.
- Ensure that all cranes are inspected frequently by persons thoroughly familiar with the crane, the methods of inspecting the crane, and what can make the crane unserviceable. Crane activity, the severity of use, and environmental conditions should determine inspection schedules.

- Ensure that the critical parts of a crane—such as crane operating mechanisms, hooks, air, or hydraulic system components and other load-carrying components—are inspected daily for any maladjustment, deterioration, leakage, deformation, or other damage.

What must employers do to ensure the safe use of slings?

As an employer, you must designate a competent person to conduct inspections of slings before and during use, especially when service conditions warrant. In addition, you must ensure that workers observe the following precautions when working with slings:

- Remove immediately damaged or defective slings from service.
- Do not shorten slings with knots or bolts or other makeshift devices.
- Do not kink sling legs.
- Do not load slings beyond their rated capacity.
- Keep suspended loads clear of all obstructions.
- Remain clear of loads about to be lifted and suspended.
- Do not engage in shock loading.
- Avoid sudden crane acceleration and deceleration when moving suspended loads.

What must employers do to protect workers who operate powered industrial trucks?

Workers who handle and store materials often use fork trucks, platform lift trucks, motorized hand trucks, and other specialized industrial trucks powered by electrical motors or internal combustion engines. Employers must make these workers aware of the safety requirements pertaining the design, maintenance, and use of these trucks.

What safety precautions should employers and workers observe when operating or maintaining powered industrial trucks?

When operating or maintaining powered industrial trucks, you and your employees must consider the following safety precautions:

- Fit high-lift rider trucks with an overhead guard if permitted by operating conditions.
- Equip fork trucks with vertical load backrest extensions according to manufacturers' specifications if the load presents a hazard.
- Locate battery-charging installations in designated areas.
- Provide facilities for flushing and neutralizing spilled electrolytes when changing or recharging batteries to prevent fires, to protect the charging apparatus from being damaged by the trucks, and to adequately ventilate fumes in the charging area from gassing batteries.
- Provide conveyor, overhead hoist, or equivalent materials handling equipment for handling batteries.
- Provide auxiliary directional lighting on the truck where general lighting is less than 2 lumens per square foot.
- Do not place arms and legs between the uprights of the mast or outside the running lines of the truck.

- Set brakes and put other adequate protection in place to prevent movement of trucks, trailers, or railroad cars when using powered industrial trucks to load or unload materials onto them.
- Provide sufficient headroom under overhead installations, lights, pipes, and sprinkler systems.
- Provide personnel on the loading platform with the means to shut off power to the truck whenever a truck is equipped with vertical only (or vertical and horizontal) controls elevatable with the lifting carriage or forks for lifting personnel.
- Secure dockboards or bridge plates properly so they won't move when equipment moves over them.
- Handle only stable or safely arranged loads.
- Exercise caution when handling tools.
- Disconnect batteries before repairing electrical systems on trucks.
- Ensure that replacement parts on industrial trucks are equivalent to the original ones.

Checklist for Materials storage and handling

1. Clear and mark transport routes.

2. Keep aisles and corridors wide enough to allow two-way transport.

3. Make the surface of transport routes even, not slippery, and without obstacles.

4. Provide ramps with a small inclination instead of small stairways or sudden height differences within the workplace.

5. Improve the layout of the work area so that the need to move materials is minimized.

6. Use carts, hand-trucks and other wheeled devices, or rollers when moving materials.

7. Use mobile storage racks to avoid unnecessary loading and unloading.

8. Use multi-level shelves or racks near the work area in order to minimize manual transport of materials.

9. Use mechanical devices for lifting, lowering and moving heavy materials.

10. Reduce manual handling of materials by using conveyers, hoists and other mechanical means of transport.

11. Instead of carrying heavy weights, divide them into smaller lightweight packages, containers or trays.

12. Provide handholds, grips or good holding points for all packages and containers.

13. Move materials horizontally at the same working height.

14. Eliminate tasks that require bending or twisting while handling materials.

15. Keep objects close to the body when manually handling materials.

16. Combine heavy lifting with physically lighter tasks to avoid injury and fatigue and to increase efficiency.

17. Provide conveniently placed waste containers.

Hand tools i.e. cutting and iron

Cutting section:

Cutting section is the preliminary section in the garment industry. A large number of fabric is cut together in the cutting section with the help of electric cutting machine. The garment manufacturing process from sourcing of fabric to fabric testing, fabric quality inspection and audit to cutting of fabric are performed by different teams. All changes and update requirement must be communicated to the right person on time. If there is gap in communication between two departments, there might be chance of making mistakes and consequences might be resulted in a big loss of revenue.

There are two parts before cutting. These are fabric inspection and fabric relaxation.

When the fabrics are received from the dyeing and finishing section, it needs to be checked, because, faulty fabrics can be supplied from dyeing and finishing. But the cutting section has to check it. Otherwise the end products will be faulty. For this, the fabric is being inspected by the quality inspector of the cutting section. They check the fabric fully and find out the faults. Then mark it so that, these faulty portion of the fabric can be rejected during spreading and cutting. Then the fabric is being stored for relaxation.

Similarly when the fabric comes from the dyeing and finishing, the fabric remains a slightly hot. In dryer, compactor heat is applied on fabric. So moisture is removed from the fabric and it is not in actual condition. But if we keep the fabric in normal temperature and pressure for a certain time, the fabric absorbs moisture from the atmosphere and regains its original nature. This process is called fabric relaxation. Another cause of fabric relaxation is to maintain the dimensional stability of produced garments. When the fabric is being processed in different finishing machines, it goes under certain heat and pressure to give it proper shape. But when the heat and pressure is being withdrawn, the shape may change. So, if the dimension is became stabilized before cutting, no chance of strain in garments. So relaxation is very necessary before cutting.

In the cutting section the supervisors must ensure the following factors for every workers. These are:

- Every workers must wear metal hand gloves while operating cutting machine
- Don’t use loose wire. All power supply must be covered
- The workers should wear mask

Iron section:

Pressing or ironing is one of the important processes in the finishing department of readymade garments industry. Pressing or ironing is the most important finishing process in readymade garments

sector which is done by subjecting a cloth to heat and pressure with or without steam to remove unwanted creases and to impart a flat a appearance to the garments. Pressing or ironing also done to introduce creases in the apparel. In the garments manufacturing industries, pressing is termed as ironing. There are different types of pressing process applied in the garment industries.

The pressing or ironing of garment is categorized into five according to the garments types, designs and materials are given below:

- No pressing,
- Minimum pressing,
- Under pressing,
- Final pressing,
- Permanent pressing

In the ironing section, following things should be taken into consideration.

- The workers should stand on a board which is nonconductive to electricity to avoid electric shock
- The workers should wear musk
- The wires should be hanged properly to avoid electric dysfunctions

Machine safety

CHECKPOINT

Design controls to prevent unintentional operation.

WHY

Unintentional operation of controls can cause serious injuries or damage, and lower productivity.

Unintentional operation can happen especially when many controls are situated in close proximity and the incorrect control is activated.

Where the layout and design of controls consider unintentional operation, workers feel more secure and can concentrate properly on their tasks.

SOME MORE HINTS

— Make sure covers and cages do not hide the control or confuse the worker. If the control protector makes the control difficult to see, consider using a clear or see-through device.

— When purchasing new equipment, look for machine designs that minimize unintentional activation. Useful designs include: mounded controls; recessed controls; controls that require two different actions (e.g. pull towards the operator and then pull towards the floor); or two controls that are required to be activated simultaneously.

RISKS / SYMPTOMS

activating wrong control
serious injury or accident

HOW

Design the layout of the controls to separate those that could be unintentionally activated.
Cover or “cage” controls that are likely to be turned on or off unintentionally.

Design a control that considers the possibility of unintentional activation. For example, if people are likely to activate a control accidentally by leaning on it and pressing, then select a control that requires pulling to activate it. Always consider that controls should still be moved in the expected direction.

Replace existing controls that can be unintentionally activated with controls that have more resistance and are harder to activate. However, the controls should not be so difficult to use that operators cannot activate the control when they want to do so.

Locate particularly important controls, such as power on-off or emergency switches, away from other controls. This helps avoid inadvertent activation during normal operations. Naturally, controls should still be within easy reach.

If there are controls or displays that are clearly superfluous and not used, remove them from the display panel.

POINTS TO REMEMBER
Turning a machine on or off unnecessarily is dangerous to people and bad for equipment, and slows production. There are different ways to prevent this unintentional activation.

CHECKPOINT
Make emergency controls clearly visible and easily accessible from the natural position of the operator.

WHY
Emergency situations are stressful, and operators are likely to make mistakes. Emergency controls must therefore be particularly well designed so that fast action is possible without any mistakes.

In an emergency, it may happen that the operator in charge is absent or injured. Co-workers who are trained in advance about emergency operation may have to act quickly. It is essential to make emergency controls easy to find.

Even untrained co-workers must be able to find emergency controls.

RISKS / SYMPTOMS

activating wrong control
performing wrong operation
uncontrolled emergency
serious injury or accident

HOW

Make emergency controls or cords easy to reach. Put them in a location that is natural for the worker to reach (e.g. not by twisting the body).

Make emergency controls large and easy to activate. For example, use a large rather than a small push-button.

Emergency controls should be labelled and colored red or that color identified by the local culture for emergency.

Check to make sure that these controls are in line with regulatory standards.

Position emergency controls away from other frequently used controls, thereby reducing the risk of inadvertent activation.

SOME MORE HINTS

— Many types of emergency control are used. In addition to palm buttons and emergency cords, a dead man's switch may be used. As long as the switch is actively pressed the machinery keeps going. If the pressure is released the machinery stops.

— Make it possible for the machine to switch itself off automatically in the event of a worker inadvertently coming into a danger area. For example, some rotating machinery has emergency trip-cords located above the operator's feet; if the operator is pulled into the machine, the feet will catch the trip cord and the machine will stop.

— Think of innovative ways to automate emergency action. For example, a worker could step on a "pressure mat".

POINTS TO REMEMBER

Emergency situations are very stressful. Even trained workers may make mistakes. Emergency controls must be designed so that there is no chance of mistakes in activating the controls.

CHECKPOINT

Make different controls easy to distinguish from each other.

WHY

If controls look similar, people will make mistakes. Activation of a wrong control may lead to an accident.

Controls that are quick and easy to find will save time and reduce operator errors.

Controls are sometimes easy to distinguish just because they have different locations. But often this is not sufficient. By adding another feature, such as color, size, shape or labels, controls are much easier to distinguish from each other. This is called “coding” of controls.

RISKS / SYMPTOMS

activating wrong control
performing wrong operation
serious injury or accident

HOW

Use different colors, sizes or shapes for switches and other controls:

– use different colors for different controls;
– use controls of different sizes;
– use control knobs of different shapes.

Label the controls. Attach clearly visible, simply worded labels. Use labels written in the local language.

Standardize the location of common controls on similar machines. For example, place controls in an easy-to-identify sequence (from fan 1 to fan 2 to fan 3, etc.) or in a place where it is easy to identify which control corresponds to which display (placing the heat-controlling knob directly under the temperature dial, etc.). In this way, the control panels for similar machines should also look alike. This will reduce errors in operation.

SOME MORE HINTS

— Make emergency controls (such as an emergency cut-off switch) look very different and easily visible by means of colour, size and shape.
— Use no more than three different sizes of control knob, because people cannot distinguish more than three sizes.
— The shape of a control knob can be made to look like the controlled function (e.g. a control for a fan can look like a fan).
— Color coding does not work in dark environments.
— Labels can be put above, underneath or at the side of controls, as long as they are clearly visible.

POINTS TO REMEMBER

Coding of controls (by color, size, shape, label and location) can prevent operator errors and reduce the time for operation.

CHECKPOINT
Make sure that the worker can see and reach all controls comfortably.Work operations are best done around elbow level. This “elbow rule” can be applied to determine the correct hand height during operations.

WHY
All items that are touched by the hands need to be organized. In many cases workers themselves organize these items at the workstation, but often they do not.

If controls are not easy to see or reach, operators tend to use them by relying on habits and guess-work. This can cause mistakes.

Time and effort are saved by placing controls within easy reach. Controls placed too high cause shoulder pain, and controls placed too low cause back pain. It is important to locate them in a place that is easy to reach from a normal working posture.

RISKS / SYMPTOMS
excessive reach
muscular strain
activating wrong control
upper limb disorder

HOW
Place the most frequently used controls or controls used for most of the time in front of the operator so that the control operation is done at around elbow height without bending or twisting the body.

Controls of secondary importance may be placed next to the most important controls. In any case, they should be within easy reach from the normal working position. Avoid places where twisting of the body becomes necessary for operating the controls.

If control positions are too high, use a platform to raise the floor on which the worker stands or sits for work. If control positions are too low, try to raise them by relocating them or putting a platform under the machine or workbench.

SOME MORE HINTS
— It is useful to identify the primary hand movement area. This is between 15 and 40 cm from the front of the body and within 40 cm from the side of the body at elbow height. The secondary hand movement area is beyond the primary area but within 60 cm from the side of the body at elbow height. Position the primary controls and other primary items (hand tools, parts) within the primary area, and secondary controls and other secondary items within the secondary area.
— See that the controls are located in a good combination with other items, such as tools, parts to be grasped, semi-products to be placed on the workstation, bins, etc. Try to organize the layout of all these items based on the opinion of the experienced workers.

— The work-table surface may sometimes be divided into subtask areas where operations are done sequentially. This helps to organize the task and facilitates learning and productivity.

POINTS TO REMEMBER
A well-organized workstation will save time and is productive. The location of controls according to their primary and secondary importance helps to organize workstations.

CHECKPOINT
Locate controls in sequence of operation.

WHY
Some machines have multiple controls that are difficult to learn to operate. For example, hydraulic equipment used in mining or manufacturing may have 10–12 controls. The sequence of control operations can be made easy to learn if controls are positioned to follow the task.

When multiple controls correspond to multiple machines or machine parts, controls are often confused. This can be avoided by locating controls in the same sequence as they are operated.

By placing controls in a logical sequence, it is easier to standardize their locations between similar machines. This greatly facilitates learning.
Code the controls by color, size, shape or label to make it easier to distinguish between them.

SOME MORE HINTS
— Workers sometimes modify controls or control knobs to make them easier to operate. Look out for such modifications, because they indicate that there is a need for change.

— Make a list of the different subtasks and the sequence of control operations. Ask the worker to help out and verify this information. Then consider if changes in location will be useful.

— Ask the workers if controls corresponding to different operations are easy to find without mistakes. If not, try to change their locations or introduce coding.

RISKS / SYMPTOMS
activating wrong control
performing wrong operation
serious injury or accident

HOW
Identify subtasks in machine operation, such as “power on-off”, “setting up”, “operating” or “moving machine”. See if controls for each subtask are easy to distinguish from those for other tasks.

Reposition controls by changing electrical connections (or even changing hydraulic hoses, if possible) so that controls associated with each subtask are grouped together.

Position controls according to the sequence of operation within each subtask (e.g. position controls A, B and C in this sequence when the corresponding operations A, B and C are done in the same sequence).

Similarly, position controls according to the different machines or machine parts (e.g. position controls A, B and C in the same sequence as the corresponding machines A, B and C).

POINTS TO REMEMBER
Workers will make fewer errors if controls are located in an easy-to-understand sequence. This improves both safety and productivity.

CHECKPOINT
Use natural expectations for control movements.

WHY
Most people have expectations of how a control should be moved.

In a car,there is a clear expectation to move the steering wheel in the same direction as the road turns. A car designed differently would be a disaster.The same principles apply to machine controls.

Note that expectations may be different in different countries. For example, in many countries (e.g. India) a light switch is turned down to turn on the light, while in others (e.g. the United States) the light switch is turned up.

RISKS / SYMPTOMS
activating wrong control
performing wrong operation
serious injury or accident

HOW
Use the expectations in the following:

Desired action	Expected control movement
Turn something on or down (up in some countries)	Right or forward or clockwise
Turn something off or up (down in some countries)	Left or back or anti-clockwise
Move something right	Right or clockwise
Move something left	Left or anti-clockwise
Raise something	Up, back
Lower something	Down, forward
Retract something	Pull back or up
Extend something	Push forward or down
Increase something	Up or right or clockwise
Decrease something	Down or left or anti-clockwise

Open a valve Anti-clockwise
Close a valve Clockwise

Make sure that the control movements of different machines or power switches use the same principles.

SOME MORE HINTS
— Some control expectations are more “natural” than others. For example, to raise an overhead crane a vertical control would move up and down,but a horizontal control would move forward and backward. For the horizontal control there is a one-to-one correspondence between the movement of the control and the crane. This is a strong expectation.
— For a horizontal control that pulls back and forth, expectations would be more mixed, because there is no clear one-to-one correspondence. A few people would probably push the control forward to raise the crane. It is better to avoid this confusing control movement.
— Keep the dial movement and control movement corresponding with each other. For example, if the the dial pointer moves to the right by increasing something, the control placed beneath should also be moved to the right (or clockwise) to increase it.

POINTS TO REMEMBER
People have expectations of how to move controls. Do not violate them. Use these expectations to your advantage to reduce control errors and to make production more effective.

CHECKPOINT 38
Limit the number of foot pedals and, if used, make them easy to operate.

WHY
Foot pedals can be useful as alternatives to hand controls. They are particularly useful when both hands are busy. The use of foot controls can also free space in a workstation. Foot controls, however, often require keeping a special posture and thus restrict the operator’s movement. This is particularly critical for standing operators.

Foot pedals that are operated repetitively by one foot cause one-sided strain, which may lead to back pain.

Foot pedals cannot be easily seen from the normal working position. Special care must be taken to prevent stumbling or inadvertent activation.

RISKS / SYMPTOMS
- muscular strain
- low back pain
- slips, trips or stumbles
- leg/foot injury

HOW

Limit the number of foot pedals to a minimum when their use is necessary.Avoid as much as possible foot pedals that are operated repetitively by one foot only.

Locate a foot pedal at floor level in order to avoid uncomfortable foot positions. A pedal level that can be reached only by raising the foot away from the floor is uncomfortable, and forces the worker to maintain an unnatural posture.

Make it possible to move the location of a foot pedal on the floor.
Make the foot pedal large enough to fit the sole of the foot.
Consider using a footrest at the side of the pedal.

SOME MORE HINTS

— Foot controls are good for many applications if adequate care is taken about the working posture and ease of operation. They are even used as a cursor control for computers (a “foot mouse”).
— Be careful in locating foot controls, because they can be a tripping and falling hazard.
— Adjustability of the location of a foot pedal is important to improve workers’ comfort and convenience. This is helpful especially for standing operators.

POINTS TO REMEMBER

Foot controls are beneficial when the hands are busy with other tasks, and where there is limited space at the workstation. Make it possible to adjust the location of a foot pedal on the floor, particularly for standing operators.

CHECKPOINT

Make displays and signals easy to distinguish from each other and easy to read.

WHY

Displays and signals carry information about work, and they should be easy to identify.It is important to consider the location of displays and signals, and also to make them easily distinguishable from each other.

Good visibility of pointer positions, characters and numbers on displays or signals also ensures high-quality work.

Incorrect reading of displays or signals is sometimes critical, as this may lead to operation failures and accidents.

RISKS / SYMPTOMS

performing wrong operation
missing signal or display change
serious injury or accident

HOW

Put important displays or signals where operators are normally looking. Locate the most important ones at a viewing angle of about 20–50 degrees below the horizontal line from the operator's eyes.

Use different sizes, shapes or colours when different displays or signals are used by the same operator. Using colours for coding different information is often the easiest way to do this.

Make the characters and numbers large enough so they can be easily read at a distance. For example, for an operator viewing a display at 1 m distance in good illumination (say,500–800 lux, as in the case of a well-lit office), a character height of 5–10 mm is appropriate. As viewing distances increase or reading conditions get worse, the size of characters should be increased.

Use display markers that are easy to read. Very detailed marks and crowded numerals disturb the reading. It may sometimes help to use different colours for different sections of a display.

SOME MORE HINTS

— Displays located in the peripheral viewing field are difficult to monitor. For example, if a display is located at more than 50 degrees from the central viewing point, the operator must turn their head to read the display. Under such conditions operators make more errors or even omit reading the displays.
— Good location of the displays, controls and corresponding machines is important. Use a layout for displays so that it is easy to understand the relation to machines and controls. It is very useful to group related displays and place them in sequence of operation. For example, displays placed just above the corresponding controls greatly help the operator in finding the control.
— Ensure good lighting on displays and signals in the evening or night hours.
— Displays can often be shown by means of a visual display unit (VDU). Presentation on a VDU screen offers an extra challenge, because the screen is small. Displayed information that is easy to understand and easy to read is equally important on VDU screens.

POINTS TO REMEMBER

Displays should be put in a location where operators look. Make different displays easy to distinguish from each other.Characters and scale markings must be of adequate size and clearly visible from the normal position of the operator.

CHECKPOINT

Use markings or colours on displays to help workers understand what to do.

WHY

For some tasks it may be necessary to display an exact numerical value,such as time in minutes. For other tasks it is enough to know if the value is within a certain range. One example is water temperature. It may be enough to know that the temperature is below boiling point.

Displays are there to help a worker carry out the right operation. Often workers themselves add markings to displays. Use these ideas to change displays to “helpful displays”.

RISKS / SYMPTOMS

performing wrong operation
missing signal or display change
serious injury or accident

HOW

Add markings to indicate the point or ranges where a certain action is always necessary (e.g. temperature or speed limit).

Use colour coding. For example, green areas or numbers mean acceptable. Red means unacceptable.

Group related displays together and organize them for easy inspection. For example, a break in the pattern of pointer positions is easy to see (e.g. if horizontal or vertical positions of all the pointers in the group mean that the operation is progressing correctly, then it is easy to find a pointer deviating from this pattern).

SOME MORE HINTS

— Usually two different types of display are available:
(i) a counter with numbers; and (ii) a moving-pointer display which shows an approximate value. A moving pointer is appropriate for showing trends and changes (such as increases or decreases). In this case, the operator is not interested in detailed numbers.
— Position important displays where operators will normally be looking.
— Avoid parallax effects that occur when the position of a moving pointer somewhat above the dial surface is wrongly read by an operator looking at the dial from the side. Place the dial surface vertical to the line of vision or place such important displays in front of the operator.

POINTS TO REMEMBER

Displays should tell workers what to do. Use markings or colours for this purpose.

CHECKPOINT

Use symbols only if they are easily understood by local people.

WHY

Symbols are sometimes used to identify machines, chemicals, controls and displays. In fact, many international manufacturers of machines prefer to use symbols, because they do not have to translate a label into the local language. But many symbols are difficult to understand, particularly those referring to machine functions that are hard to visualize or imagine. It is often better to use a short message instead.

Good symbols can be used insofar as they are easily understood by local people.

RISKS / SYMPTOMS

performing wrong operation
missing signal or display change
serious injury or accident

HOW

Use symbols only if you are absolutely sure that they are easily understood by all the workers concerned.

Simple symbols are better,but be aware that there are not many symbols that are universally understood.

Take several workers, one at a time, to the machine and ask them to identify the symbols. If a symbol is understood by all workers, there is no problem. If it is not understood by some workers, make a label and attach it to the machine.

Do not hesitate to add labels. They will prove essential in critical situations. Labels should be designed in accordance with local culture and stereotypes. The labels should be made to withstand wear and tear.Metal or plastic plates are the best solution.

SOME MORE HINTS

— Well-understood symbols have an advantage in that they are quicker to read than a label. There are widely accepted and widely used symbols, as in the case of no smoking signs, emergency exits and hazardous chemicals.
— If you want to propose your own symbols, get workers to evaluate them.

POINTS TO REMEMBER

Symbols that are difficult to understand should be supported by labels. If in doubt, ask the workers.

CHECKPOINT

Make labels and signs easy to see, easy to read and easy to understand.

Make sure that labels and signs use language that can be understood by the workers.Where there is more than one language group, it may be necessary to use different languages in labels and signs.

WHY

Labels and signs must be easy to read, otherwise they will be ignored.

People tend to read labels and signs only at a short glance, and therefore often make mistakes in reading them. This may lead to performing the wrong operation and may cause an accident. Labels and signs must be large and clear enough to be easily read at a distance.

Text must be made easy to understand so that people will know what to do.This is productive because it will save time.

RISKS / SYMPTOMS

performing wrong operation
missing signal or display change
serious injury or accident

HOW

Locate labels and signs in places where people often look, for example close to the production process or in front of each operator.

In a workplace where the operator stays in the same place, locate labels and signs at a comfortable viewing angle from that position, i.e. about 20–40 degrees below the horizontal.

Make the lettering large enough to be easily read at a distance.

Where appropriate, use different colours or shapes for different labels or signals.

Put labels for displays and controls immediately above, underneath or to the side so that it is clear which label corresponds to which display or control. Make sure that these labels are not obscured by other elements.

Make the message clear and short. Avoid confusing and lengthy text.

SOME MORE HINTS

— Locate labels and signs so they do not pick up reflections from light sources, which can cause glare. Sometimes you can change the angle of a sign to reduce reflections (as for a rear-view mirror in a car).
— Use materials such as plastic or steel that can easily be cleaned of dirt and oil, and so that the sign will remain visible for years to come.
— Labels with 1 cm high lettering are normally sufficient at workstations.
— When indicating a required operation, start the message with an action verb so that people know exactly what to do (e.g.“Turn off lights”,“Hook the sling”, not “Turn off lights if not necessary” or “Danger – Watch the crane”).

POINTS TO REMEMBER

Labels and signs can give much important information. Locate them where the workers look, make them large enough, and make the message short and easy to understand. This will reduce errors and save time.

CHECKPOINT 43

Use warning signs that workers understand easily and correctly.

WHY

Warning signs are used to warn against hazards. They often carry a complex message, because it is necessary to convey what the hazards are and what the person should do to avoid them. Make sure that warning signs are easily understood by workers.

Lengthy warning signs are in fact not read by all workers. It is important to choose compact but easy-to-understand messages.

The effectiveness of warning signs can be enhanced by symbols. An example of a good warning sign:
DANGER!
HIGH-VOLTAGE WIRE
CAN KILL!
STAY AWAY!

RISKS / SYMPTOMS
serious injury or accident
electrocution
delayed evacuation

HOW
Use a warning sign that contains four essential elements:
A signal word – to convey the gravity of the risk, for example “Danger”,“Warning” or “Caution”. “Danger” is the most severe signal word and “Caution” the least.
The hazard – the nature of the hazard.
The consequence – what could possibly happen.
An instruction – what is the appropriate behaviour to avoid the hazard.
Ensure that the appropriate signal word – such as “Danger”,“Warning” or “Caution” – is used. Also make sure that the descriptions of the nature of the hazard and the consequences are appropriate. Check if the instruction to workers about what to do is clear enough.

SOME MORE HINTS
— Note that short messages are more effective than long ones.
— General warning signs, such as those that merely say “Danger”,“Look out” or “Warning”, are not effective. They are too general,and people do not understand what to do.
— Written warning signs assume that workers are able to read.When easy-to-understand symbols are available, use both symbols and written signs.

POINTS TO REMEMBER
Warning signs must spell out what the danger is and what to do.

CHECKPOINT
Use jigs and fixtures to make machine operation stable, safe and efficient.

WHY
Jigs and fixtures hold work items firmly in correct positions. They make the operation more stable and more efficient.

Fixtures leave both hands free to work.

Jigs or fixtures keep the hands away from tools or operational sections of the machine. This is because the jigs or fixtures, and not the hands, hold the work items. This increases safety and efficiency.

RISKS / SYMPTOMS

muscular strain
repetitive strain
upper limb disorder
hand/finger injury

HOW

Design a jig that guides a tool or an operating part of the machine to a precise location on the work item. This will increase efficiency.

Alternatively, use a fixture that holds one or more items for processing.This frees the hands.

Always use jigs and fixtures in such a way that they firmly hold the workpiece while preventing its movement in either direction along the X,Y and Z axes, and rotation in either direction about the X,Y and Z axes.

Make the jigs and fixtures easy to load and unload.

Standardize components of jigs and fixtures (bases, bushes, pins, clamps) to minimize costs and speed repairs.

Establish a plan to maintain jigs and fixtures properly and make it clear to all concerned workers, so that they know what to do if the parts in the jigs or fixtures are defective (whom to contact, etc.).

SOME MORE HINTS

— As the jig or fixture weight increases, consider mechanical handling instead of manual handling.
— Chamfer sharp edges.
— Make jigs and fixtures sturdy, as they tend to get rough treatment. Use wear strips on the base where they are in contact with a conveyor. Use plastic or rubber “bumpers”.

POINTS TO REMEMBER

Don't use the hand as a fixture. For that purpose, use a jig or a fixture.

CHECKPOINT

Purchase machines that meet safety criteria.

WHY

There are safe and unsafe machines. Care should be taken to purchase machines that are constructed safely.

Safe machines are machines in which dangerous parts are situated in a position where they cannot harm the worker. Using these safe machines is the best way to prevent accidents.

After purchasing machines, it is usually difficult to make them safer as production continues. Often additional guards or enclosing the dangerous parts can help, but it is better to purchase machines in which all these necessary guards are already in place.

RISKS / SYMPTOMS

serious injury or accident
hand/finger injury
wrong operation

HOW

When purchasing a machine, study the options carefully and order one in which all moving parts are guarded and points of manual operation are free from danger.

Confirm whether rotating shafts, wheels, rollers, pulleys and gears, as well as reciprocating motions, are adequately guarded.

Check whether feeding and ejection can be done safely without the hands coming into a dangerous point while the machine is in motion.

Also check whether maintenance of the machine can be done safely. In particular,the motion of the machines should be locked while they are repaired or while the maintenance work is performed.

Make the manual for proper operation of the machine available to all the workers concerned and provide training. Make sure that operating instructions and labels are in the language easily understood by the workers. Keep in mind that some workers may not read well or at all; provision of training is essential.

You may be offered a machine without guards or unsafe versions at a lower price. Such machines can cause you many problems and cost you more in the long run. Save yourself a lot of trouble and expense by choosing the right machines.

SOME MORE HINTS

— Automatic or mechanical feeding and ejection devices can eliminate risks while greatly increasing productivity.
— Interlock guards are preferable because electrical or mechanical cycling of the machine is automatically interrupted if the guard or cover is opened or removed for operation or maintenance.

POINTS TO REMEMBER

Working in fear of accidents greatly hampers good work results. Install safe machines that cannot harm workers. Safe machines are productive and reduce injuries.

CHECKPOINT

Use feeding and ejection devices to keep the hands away from dangerous parts of machinery.

WHY

With feeding and ejection devices, objects can be handled with greater precision and without risk of injury.

Feeding and ejection devices can greatly reduce the time for feeding and unloading. Using the time saved, the worker can carry out other tasks, such as preparing for the next work item. This means less idle time for the machine.

The use of feeding and ejection devices makes it possible to remove wastes or toxic substances without handling them manually.

RISKS / SYMPTOMS

serious injury or accident
hand/finger injury
repetitive strain

HOW

There are many different types of feeding/ejection device. The following are some examples of simple types:

plunger feed: a plunger with a die (a slot or nest) into which the stock is placed outside the point of operation and then pushed into the point of operation as the machine is cycled;

carousel feed: a carousel type of feeder is one in which the stock is placed outside the point of operation and put under the point of operation one item at a time, combined with automatic ejection and collection of finished stock;

gravity chute feed: automatic placing of the stock in the point of operation or in the plunger device, thus saving the worker from having to place new stock at each cycle.

Use compressed air for feeding semi-solid or granular materials.

Use an ejection device that is part of the feeding system. This saves ejection time.When a separate ejection device is needed, use a mechanical device or compressed air.

Use feeding aids, such as hooks, bars or other extensions, to feed or remove objects. In each individual case an appropriate solution must be developed. For example, use a hook with a rounded handle to remove cutter shavings from a turning lathe.

SOME MORE HINTS

— There are many other ways to benefit from “free” gravity. In some cases, a simple inclined chute feeder can be used to move the stock into the point of operation.
— The feeding and ejection devices must not interfere with existing guards or other safety devices.
— The maintenance of feeding and ejection devices or removal of an operation failure must not cause an inadvertent cycling of the machine.
— The correct height and the placement of the feeding devices make work easier and more efficient.

POINTS TO REMEMBER

Use feeding and ejection devices to increase productivity and reduce machine hazards.

CHECKPOINT

Use properly fixed guards or barriers to prevent contact with moving parts of machines.

WHY

When working near moving parts of a machine, workers are at risk. Injuries may occur from the power transmission parts (such as gears, shafts, wheels, pulleys, rollers, belts or hydraulic lines), from the point of operation, or from flying objects such as chips, sparks or hot metal. The best

protection against the risk is by preventing contact through mechanical means, not by instructing workers to avoid it.

Accidents may happen during normal operation or during cleaning and maintenance. Often bystanders and other workers can be at risk, since they do not understand how the machine operates or what precautions are necessary. Observe the national standards that prescribe the use of machine guards and barriers, and improve on these further to protect people.

RISKS / SYMPTOMS

serious injury or accident
hand/finger injury
eye injury

HOW

Design a fixed guard that can be attached to the machine for protection against both the machine itself and flying objects. The guards must be practical to use. They must meet the requirements of the machine and the specific danger.

If the machine guard hinders manual operation, or if workers cannot see the task clearly,they will most likely remove the guard. Redesign these guards, or replace them with adjustable guards that can be adjusted to suit the size of work items being introduced into the point of operation and still provide a high degree of protection.

To make it possible to see the task clearly,use machine guards made of plastic or see-through material.

Put up fixed barriers in places where contact with moving parts of the machine is possible, even though this danger is not readily visible. Make sure that these barriers are stable and high enough for the purpose.

Where one moving part comes into contact with another and thus makes up a “pinch point”, put up fixed barriers or appropriate guards to prevent fingers or hands from being caught.

Similarly, when two rotating rollers roll together and thus make up a “nip point”, erect appropriate guards to prevent hands or clothing from being caught.

SOME MORE HINTS

— Guards may be attached directly to the machine or to a stable surface such as a wall or a floor.They should be made of strong material and provide protection against flying fragments.
— Fixed guards should be removable only by using tools.
— Fixed guards at the point of operation should be accompanied by appropriate feeding and ejection devices so as to facilitate safe operation and increase efficiency.Special hand tools may also be used to reach into the point of operation and manipulate work items (e.g. pliers and tongs with vacuum suction devices or magnetic lifters at the end).
— Manufacturers of machines usually supply machine guards. Sometimes these are impractical and you may find that it is necessary to design your own guards.

POINTS TO REMEMBER

Machine guards and barriers are important to protect workers and bystanders. If you find that they are not used, immediately seek an adequate solution by erecting a redesigned guard.

CHECKPOINT
Use interlock barriers to make it impossible for workers to reach dangerous points when the machine is in operation.

WHY
Accidents quite often happen when the worker opens or removes the guard or cover. If the machine stops when the guard or cover is opened or removed, there is no danger.

Interlock guards or barriers automatically interrupt the electrical or mechanical cycling of the machine as soon as the guard or cover is opened or removed.

Interlock systems may also block access to the point of operation just prior to the work cycle.

RISKS / SYMPTOMS
serious injury or accident
hand/finger injury
eye injury

HOW
Construct a fence with a gate to enclose the process. An interlock barrier typically requires a key to open the gate.When the gate opens, an automatic switch turns off the power supply to the machine. The interlock gate needs to be closed before the dangerous machine starts moving again.

Where mechanical interlocking is difficult to apply, use photosensitive interlock systems. They interrupt the machine operation whenever any part of the body is beyond “light barriers” that have light sources on one side and light-receiving parts on the other.

Great care must be taken when a process continues in its cycle, to see that it takes more time to open the gate than the process takes to stop.

If interlocking is not possible, two-hand controls can be used. Two-hand controls require that two switches or levers must both be operated at the same time with both hands. In this way,the worker's hands are always outside the machine while it operates.

SOME MORE HINTS
— Because interlocks or two-hand controls may be inconvenient for the production process, they are sometimes tampered with. The interlocks and their switches should be designed so that they are tamperproof and cannot be easily broken or overridden with screwdrivers, pencils or adhesive tape. Two-hand controls should be designed so that the two switches cannot be operated with one hand, taped or jammed on, pressed with the knee or otherwise circumvented.
— A large space behind the interlocking barrier can cause a serious hazard, because it is possible to close the gate behind a worker inside the danger area. Somebody else, being unaware of the presence of the worker inside, may close the gate and thus activate the machine. The key should therefore be used both for closing and opening, and the worker should be told to put the key in his or her pocket so that no one else can use it while inside the danger area.
— Interlocks are also common on electrical equipment. The process equipment may be enclosed in a box with an opening and a key.The key opens up the box and breaks the power supply.

POINTS TO REMEMBER

An interlock is an effective means to protect workers from the danger area of a machine. It is used to turn off a production process automatically,making it possible for workers to reach work items for inspection or repair.

CHECKPOINT

Establish safe procedures for forklift driving by modifying the workplace and providing adequate training.

WHY

Safe driving of forklifts is important for safe and efficient materials handling, as forklifts come in contact with many people at the workplace. Most of these people are doing other tasks, and may be injured by suddenly encountering the running forklifts.

Forklift drivers perform a variety of tasks, such as loading, driving, unloading and assisting workstation operators. It is sometimes difficult to see the roadway over the loads. Support for easier forklift driving can greatly enhance workplace safety.

Unnatural postures often occur for forklift drivers during travelling in reverse and over uneven ground. Twisted postures and whole body vibration may increase the potential for musculoskeletal disorders. Appropriate driving practices can reduce such risks.

When the work area is restricted in space, forklifts may run into structures such as racking and doorways, and may even harm pedestrians. Keeping roadways cleared and establishing smooth travel procedures can reduce these risks.

RISKS / SYMPTOMS

- serious injury or accident
- muscular strain
- low back pain
- leg/foot injury
- whole-body vibration
- product damage

HOW

Maintain the roadways used by forklifts to eliminate uneven surfaces such as potholes and poorly fitting dock plates. Separate the walkways for pedestrians from the roadways used by forklifts.

Use a checklist to ensure the key safety features of forklifts and travel routes are operational before daily use. Make sure barriers are in place around corners of racking or doorways. Ensure that a warning siren and a reverse light are activated in reverse travel.

Secure your safety belt and make sure the load is within the forklift’s rated capacity.

Provide support for increasing the comfort of forklift driving, such as a vibration-absorbing seat, mirrors or spotters, increasing overhead clearance, selecting appropriate pallets, etc.

Provide training for the driver on how to operate the forklift safely.This includes proper and balanced lifting, travelling at an appropriate speed, always looking in the direction of travel, keeping the arms and legs inside, moving slowly into position, unloading keeping necessary allowances, etc.

If rollover bars are not fitted, retrofit the forklift with appropriate equipment.

SOME MORE HINTS

— Purchase forklifts equipped with rollover protection that can protect the driver in the event that the forklift rolls over.

— Introduce a roadway maintenance program to avoid potholes developing. Ensure the visibility of the working environment for the driver and for the pedestrians.

— Locate the truck loading area close to the storage area for the pallets to minimize the travel distance for the forklift.

— Install speed-limiting devices to forklifts used in congested areas to ensure that speed levels are controlled.

POINTS TO REMEMBER

A forklift is a large piece of machinery that moves between the inside and outside of buildings where various kinds of work are done. Clearly defined roadways and safe travel procedures are required to manage the forklift safety.

CHECKPOINT

Inspect, clean and maintain machines regularly, including electric wiring.

WHY

A well-maintained machine is less likely to break down. A poorly maintained machine can not only have more breakdowns but can also be dangerous.

A well-maintained machine with safe wiring is less likely to catch fire and electrocute workers.

Machine guards should also be inspected, cleaned, and repaired or replaced, as necessary.

SOME MORE HINTS

— A machine maintenance programme, carried out by qualified personnel, will reduce the frequency of repairs and reduce the need for the worker to remove guards.

— Cooperation of all workers is necessary for proper maintenance and cleaning of machines. Make it clear that the maintenance programme is an essential part of good production management.

— Reward workers for inspecting and maintaining the machines.

RISKS / SYMPTOMS

serious injury or accident
electrocution
wrong operation
fire or explosion

uncontrolled emergency
product damage

HOW

Develop a schedule of routine inspection, cleaning and preventive maintenance.

Create an inspection and maintenance log (record book) for each machine and each work area. Make this log available to all workers.

Designate key personnel to be responsible for inspecting the machines and the logs.

Maintenance should also include seeing that all necessary machine guards are in place.

Train workers to perform inspections at their own work area and report deficiencies.

When machines are being repaired, or when maintenance tasks are being performed, the control mechanisms of the machines should be locked and should have a tag saying “DANGER! DO NOT OPERATE!”

POINTS TO REMEMBER

Proper maintenance does not mean lost production time. It is an investment in higher productivity,enhanced safety and lower repair costs.

Workstation design

CHECKPOINT

Adjust the working height for each worker at elbow level or slightly below it.

WHY

The correct height of places where work is done with the hands facilitates efficient work and reduces fatigue. Most work operations are best performed around elbow level.

If the worksurface is too high, the neck and shoulders become stiff and painful as arms must be held high. This happens in both standing and sitting positions.

If the worksurface is too low,low back pain easily develops as the work has to be done with the body bent forward. This is serious in a standing position. In a sitting position, too low a working height causes both shoulder and back discomfort in the long run.

RISKS / SYMPTOMS

muscular strain
excessive reach
excessive fatigue
low back pain
upper limb disorder
wrong operation

HOW

For seated workers, worksurface height should be around elbow level.Working height can be slightly below elbow level if forces need to be exerted downward. If using a keyboard, the height

at which the fingers operate should be at or slightly below elbow level. This is dependent on keyboarding abilities.

An exception should be made for high-precision work while sitting. In this case, the object can be raised slightly above elbow level to allow the worker to see the fine detail. In this case, provide armrests. A jig may also be required to support the object.

For standing workers, the hand height should be a little or somewhat below elbow level. For work requiring accuracy, elbow height can be chosen. In light assembly work or packing of large items, the hand height should be about 10–15 cm lower than elbow level.When the use of very strong force is needed, an even lower height is appropriate so as to allow the use of body weight. However,too low a work height should be avoided because it can cause lower back pain.

Where possible, use an adjustable work table, for example a lift-table with a hydraulic device for raising or lowering the table height.

Use a platform or a similar flat structure under tables, worksurfaces or work items to raise the working hand height. Use platforms under the feet or chair to lower the actual working height in relation to elbow level. These adjustments are extremely effective.

SOME MORE HINTS

— Adjusting working height is much easier than people normally think. As machines or tables are involved, people tend to think that changing work height is impossible or too expensive. This is not true. Learning from the above examples, use your own ideas.

— Adjustable work tables are available. They facilitate use of the same workstation by several people, and thus increase productivity.

— If the same work table is used for both standing and sitting work, take care to provide a higher working surface for standing work and to avoid too high a working height for seated work. This is usually done by choosing a table suited to seated workers and inserting platforms or fixtures under work items handled while standing, to raise them to the correct level. Alternatively, choose a table height for standing work and provide high chairs and adjustable footrests for seated work.

POINTS TO REMEMBER

Apply the “elbow rule” to determine the correct hand height for greater efficiency and to reduce neck, shoulder and arm discomfort.

CHECKPOINT

Make sure that the workplace accommodates the needs of smaller workers.

WHY

Differences in body size of workers are usually very large in any workplace.The differences are becoming even larger with time as workers of both sexes from different regions come together.Special care must be taken so that controls and materials can be reached easily by all workers.

Controls and materials that are too remotely placed fatigue smaller workers and reduce their efficiency.This is dangerous and must be avoided.

RISKS / SYMPTOMS
excessive reach
muscular strain
low back pain
upper limb disorder

HOW

Purchase machines and equipment with adjustable worksurface height. Then adjust the height to suit smaller workers.

Replace controls (although this might be relatively difficult once machines are bought) and materials so that they are within easy reach of smaller workers. If the same controls and materials are dealt with by taller workers, make sure that they are still within easy reach of taller workers.

Use platforms for smaller workers so that the hand position of these workers becomes higher and can easily reach controls and materials. Ensure that the stand does not present a tripping and falling hazard.

Use a foot-stand or a mobile platform to enable workers to reach particular controls or materials which are difficult for them to reach.

SOME MORE HINTS

— Ask smaller workers whether they have difficulties in reaching controls and materials. Discuss with them how this can be improved. There are usually practical ways to solve the problem.
— For a lever control, an extension can make it easy for smaller workers to operate it. Consider similar arrangements to improve the difficult reach of some controls.
— A mobile control panel or keyboard can make the workstation easily adjustable for both larger and smaller workers.

POINTS TO REMEMBER

Make sure that smaller workers can comfortably reach controls and materials.

CHECKPOINT

Make sure that the workplace accommodates the needs of taller workers.

WHY

Generally,adjustment of worksurface height for larger people is relatively easy.However, clearance for movement or clearance under the work table is difficult to expand once the workstation is installed. Clearance must be large enough from the outset to accommodate larger people.

In order to accommodate larger people, it is most important to provide adequate leg and knee clearance. Extra space is also necessary to accommodate taller people.

Enough space to move the legs and body easily will reduce fatigue and the risk of musculoskeletal disorders, thus improving the worker’s efficiency.

RISKS / SYMPTOMS
muscular strain

upper limb disorder
low back pain

HOW

Check overall space clearance of all workstations and passageways for the largest worker,and increase clearance where necessary.

Check knee and leg clearance of workstations used by the largest worker.If knee and leg clearance is too narrow,consider how the clearance can be expanded. Raise the work-table height or expand the work-table size, for example.

Mark all unsafe clearances with bright colours and warning signs.

SOME MORE HINTS

— Ask the largest worker where he or she feels unsafe or whether the space is too narrow.Take measures to deal first with unsafe conditions, and then with discomfort.

— It is uneconomical and impractical to design equipment for people of all sizes. Often equipment is designed to accommodate about 90 per cent of the proposed user population, which means that the smallest and largest 5 per cent may be excluded. In your workplace, therefore, make sure that even the largest and smallest workers feel safe and comfortable with the existing space. Just following regulations might not be enough.

— Also consider the other body-size related needs faced by larger workers: gloves, protective clothing, helmets, etc.

POINTS TO REMEMBER

Make sure that the largest workers feel comfortable and safe with the existing space.

CHECKPOINT

Place frequently used materials, tools and controls within easy reach.

WHY

Time and energy are saved by placing materials, tools and controls within easy reach of the workers.

Long reaches mean a loss of production time and extra effort.

The distance that can be reached easily without bending forward or stretching is quite small. Long reaches can thus lead to neck, shoulder and back pain, as well as to imprecise operations.

RISKS / SYMPTOMS

excessive reach
repetitive strain
low back pain

HOW

Place frequently used tools and controls within the primary hand movement area. This is between 15 and 40 cm from the front of the body and within 40 cm from the side of the body at elbow height.

Place all frequently used materials within this primary hand movement area or at the margin of this area.When materials are supplied in boxes or bins, or on pallets or racks, they should be placed within easy reach and at around elbow height.

For similar workstations, organize the placing of tools, controls, materials and other work items in a good combination with each other.For example, when several kinds of material are collected at the same time or one after another,place them in the same area in different bins. Standardize the location of all these items based on the opinions of the workers.

If appropriate, divide the work-table surface into subtask areas so that different operations are done sequentially.

SOME MORE HINTS

— It is very important to place within this primary hand movement area all the items used regularly. Let workers adjust the workstation to their needs.
— Displays and instructions can be placed beyond this easy-reach area as long as they are presented in an easy-to-read form.
— Materials, tools and controls can be placed not only on the main work table but also on a side table or a rack placed within easy reach. Less frequently used items can be placed at the side of the worker.
— Tools or materials used only occasionally (a few times per hour, for example) may be placed at a distance reached by leaning forward or stretching aside, or even outside the immediate work area, without much loss in productivity.
— Provide adjustment for left-handed workers.

POINTS TO REMEMBER

Place frequently used materials, tools and controls within easy reach. This easy-reach area is quite narrow, and you can determine it by trying to reach while keeping your natural posture.

CHECKPOINT

Provide a stable multi-purpose worksurface at each workstation.

WHY

Work at any workstation consists of a variety of tasks including preparation,main operations, recording, communication and maintenance. A stable worksurface of a certain size is needed to accommodate not only principal tasks but also various other tasks.

A worksurface that is too narrow or unsteady results in time loss and more effort, thus reducing work efficiency and increasing fatigue.

RISKS / SYMPTOMS

muscular strain
upper limb disorder

excessive reach

HOW

At each workstation provide a stable worksurface of appropriate size where a variety of tasks can be done, including preparation, main tasks, recording, communication and maintenance-related tasks. Such a surface is usually available when the work requires a work table, but tends to be neglected when the main operations do not require a table.

Avoid a makeshift worksurface or an unsteady surface.Work done on it becomes frustrating and of low quality.

The thickness of the worksurface should be not more than 5 cm. This is necessary to secure knee space underneath.Therefore avoid putting drawers or under-table shelves in front of the seated worker where the legs are positioned.

In the case of a visual display unit (VDU) workstation, a worksurface is needed, in addition to the keyboard space, for preparation, document holding, writing and maintenance.

SOME MORE HINTS

— Consider the whole working day at the workstation. Pay due attention to all the necessary preparatory and subsidiary tasks. A worksurface of a certain size is often useful even if the main tasks do not necessitate it.
— Also consider places for small tools, stationery and other personal items.
— If appropriate, use a side table, an existing flat surface on a rack or nearby workstands.

POINTS TO REMEMBER

Provide a stable worksurface at each workstation for use for a variety of preparatory, main and subsidiary tasks.

CHECKPOINT

Make sure that workers can stand naturally, with weight on both feet, and perform work close to and in front of the body.

WHY

Working operations are more stable and efficient when done close to and in front of the body in a natural posture. The workstation should be designed to allow for such operations.

Working in an unstable position might cause a costly mistake.

Fatigue of workers and the risk of neck, shoulder, arm and back disorders are reduced when the work is done avoiding unnatural postures.

RISKS / SYMPTOMS

low back pain
excessive reach
repetitive strain
upper limb disorder

HOW

Arrange all important and frequent operations so that they are carried out close to and in front of the body, and around or slightly below elbow level. Make sure that the work table or working height close to and in front of the body is free from obstacles.

Make sure that these frequent operations can be performed without raising the elbow high or bending or twisting the body long enough to cause discomfort.

Provide adjustable workstations when used by different workers or where different tasks are carried out. If adjustable workstations are impractical, provide platforms or other means to adjust the working height to each worker.Use lifting and tilting arrangements if needed.

SOME MORE HINTS

— There are two easy ways to find out about unnatural postures. First, ask the workers whether they feel pain or discomfort during work. Second, watch the work operations and find those done by stretching, bending or twisting the body.

— The optimal heights for frequent work operations are: for standing work between waist level and heart level; for sitting work between elbow level and heart level.

— Workers get tired if work operations are always done at the same place, even at the optimal place. Variations in work posture are essential. Therefore avoid repetitive tasks that need to be done in the same posture all the time.

POINTS TO REMEMBER

When work is done in a natural posture, with weight on both feet and without bending or twisting, fatigue is less and productivity is higher. Arrange for good hand positions allowing this posture

CHECKPOINT

Allow workers to alternate standing and sitting at work as much as possible.

WHY

Alternating standing and sitting is much better than keeping either posture for a long period of time. It is less stressful, reduces fatigue and improves morale. Alternating standing and sitting may mean

Combining different tasks, thus facilitating communication and the acquisition of multiple skills.

Strictly machine-paced work requires keeping the same posture. This is tiring and tends to increase mistakes. By providing chances for occasional sitting or standing, the work becomes better organized.

RISKS / SYMPTOMS

repetitive strain
monotony
upper limb disorder
low back pain
excessive fatigue
lack of acceptance

Communicating with other workers or monitoring work results, or after completing one or a few work cycles.

If appropriate, organize job rotation so that the same worker can go through different jobs alternating standing and sitting.

If alternating standing and sitting at work is not at all possible, insert short breaks to allow for the change.

SOME MORE HINTS

— If it seems difficult to introduce the new routine of alternating standing and sitting, just try to see if such changes are possible by providing standing workers with chairs for occasional sitting and by providing sitting workers with an additional space where some secondary tasks can be done while standing.This trial may facilitate a new routine.

— Multiple skills are increasingly important for various kinds of work. In arranging multi-skilled work to be done by a group of workers, it is possible to combine standing and sitting tasks for each individual worker.

HOW

Provide sitting workplaces for workers performing tasks requiring precision or detailed inspection of work items, and standing workplaces for workers performing tasks requiring body movements and greater force.

Assign work tasks so that the worker can do these different tasks by alternating standing and sitting while at work. For example, preparation while standing and sitting, power tool work while standing, inspection and recording while sitting.

If the main tasks are done at standing workstations, then allow for occasional sitting (e.g. for watch keeping, recording or at the end of a series of work tasks).

If the main tasks are done in a sitting posture, then opportunities should be provided for occasional standing, e.g. for collecting materials from storage,

POINTS TO REMEMBER

Assign work tasks in order to create opportunities to alternate standing and sitting for greater efficiency and comfort.

CHECKPOINT

Provide standing workers with chairs or stools for occasional sitting useful if these chairs or stools do not occupy too much space and do not disturb the work.

— Make sure that the place for occasional sitting is accessible and safe.

WHY

Standing all the time is very tiring. It increases pain in the back, legs and feet, and affects work quality. Occasional sitting helps to reduce fatigue.

Standing all the time is often considered a matter of discipline. But most standing workers do have the chance to sit and should be allowed to do so through the provision of chairs or stools. This helps to increase work quality and job satisfaction.

If some of the tasks carried out by standing workers can be done sitting, arrange for this to be done. Alternating sitting and standing is a good way of organizing work.

RISKS / SYMPTOMS
low back pain
muscular strain
repetitive strain

HOW
Provide a chair or stool near each standing worker. If there is no immediate space for this purpose near the workstation, put chairs or stools or a bench near a group of workers.

See if workers are using makeshift chairs for occasional sitting. Formally allow workers to use chairs when they need it.

Check if part of the tasks assigned to the standing worker can be done while sitting (e.g. some preparatory tasks or keeping watch over the machine operation). Arrange for occasional sitting work, where possible.

SOME MORE HINTS
— Various inexpensive chairs can be used for occasional sitting. Support stools for easy occasional sitting can likewise be helpful. It may be

POINTS TO REMEMBER
Occasional sitting is a good principle for standing work. Encourage it, and provide chairs or stools near the workstation.

CHECKPOINT
Provide sitting workers with good adjustable chairs with a backrest. Ensure good mobility required for the work and for occasional changes of the sitting posture while in the chair. Five-leg chairs with castors are good for many seated tasks.

WHY
Seated work seems comfortable compared with other forms of work. However, sitting for long hours is also tiring. Good chairs reduce fatigue, improve work efficiency and increase job satisfaction.

Often it is not considered worthwhile investing money in chairs. But consider that a chair can last for years, and that the cost per day is only a very small fraction of the labor cost (an estimate is 0.1 per cent or even as low as 0.01 per cent). A good chair that improves productivity and job satisfaction more than offsets this minimal cost.

RISKS / SYMPTOMS
low back pain
upper limb disorder
muscular strain
excessive fatigue

SOME MORE HINTS

— Ensure a good combination of correct seat height (lower end of kneecap level) and correct working height (elbow level). It is wrong to use a seat higher than the correct height in order to make the elbow level reach a high work table, because a high chair oppresses the thighs and restricts leg movements; this is very tiring for the worker.

— Do not use armrests for work that requires a lot of arm movements, as they inhibit mobility. Armrests are sometimes useful to give support for the whole arm. In this case, supporting the whole arm is better than just supporting the wrist.

— After adjusting the seat height so that the work is slightly below the elbow, the feet may dangle. This happens when the working height is not adjustable. In this case, use a footrest.

HOW

A suitable seat height is the height at which the worker can sit with the feet placed flat and comfortably on the floor and without any pressure to the back of the lower thigh. Provide a chair with adjustable height. Height adjustment should be very easy while sitting on the chair.

If an adjustable chair is not feasible, each worker should use a chair of correct height, or alternatively use a footrest or seat cushion in order to attain the correct floor/seat height difference.

Use a padded backrest that supports the lowest part of the back (often called the lumbar area) at waist level (about 15–20 cm above the seat surface) as people will lean both forward and backward in the chair.The backrest should also support the upper back for occasional leaning backward.

Provide a good seat surface with some padding, neither too hard nor too soft, so that the worker can easily change the sitting posture in the chair.

POINTS TO REMEMBER

Provide “ergonomic chairs” adjustable to each worker for correct seat height and with a good backrest. The chair should allow good mobility in the chair.Do not forget to instruct all workers how to adjust their chairs.

CHECKPOINT

Use height-adjusted computer workstations, and arrange related computer peripherals within easy reach.

WHY

Adjusting the height of the workstation to preferred positions of displays and controls can reduce visual, neck, shoulder and back strains.

If the display screen, keyboard and chair height can be easily adjusted, both large and small workers can use the same workstation comfortably.

The prolonged use of a laptop computer on a standard desk can be straining to the neck, hands, wrists and shoulders. This is because laptops have smaller and lower displays, smaller keyboards and track pads. Adjustable workstations can avoid these strains.

Computer peripherals that are well arranged within the reach of the worker can reduce unnecessary over-reaching motions and secure adequate lighting while reducing screen glare.

Well-adjusted computer workstations can help workers organize their work at their own pace. Workers can thus insert micro-pauses that help them recover from fatigue and work.

RISKS / SYMPTOMS

upper limb disorder
eye strain
repetitive strain
muscular strain
stress-induced disorder

HOW

Use height-adjustable furniture including a table, a chair,and a computer monitor.The table must be adjustable to fit a range of short to tall workers (in most cases 56–72 cm). The chair must have adjustable seat height and backrest angle. The computer monitor (either a CRT or an LCD) should be of adjustable height.

If a work table of adjustable height is not available, use low tables for smaller workers and higher tables for larger workers to keep the keyboard at elbow level. If only high tables are available, provide smaller workers with a high chair and a footrest positioned so that both their feet are flat on the footrest.

If a laptop is used, a flat panel LCD is preferred that the worker can use while raising the head with a better viewing angle, possibly together with an external keyboard.

Provide support for input devices such as a keyboard and a mouse. If a keyboard tray is used, position it below the elbow level. The mouse should be close to the worker so that no overstretching occurs.

Organize the work items and workstation elements (e.g. overhead cabinet, desk light, document holder, etc.) to be within arm reach of the worker. The primary workspace within easy reach must accommodate the input device, while the secondary workspace is used for the monitor and document holder, etc.

To avoid clutter, cables should be bunched together in a special cable management facility.

SOME MORE HINTS

— Train users on correct sitting posture at the workstation. Educate users on the use of various controls on the adjustable chair.
— If a standing CPU is used, position it on the side of the table. Other items that are not required should be stored away (e.g. archive manuals, documents) to increase legroom.
— Schedule rest periods to enable stretching and visual exercises such as looking back and forth on far and close objects.

POINTS TO REMEMBER

Adjust table, chair, computer monitor, and keyboard heights to each worker. This is the first step towards reducing the incidence of musculoskeletal disorders and health complaints.

Lighting

From the workers' perspective, poor lighting at work can lead to eye-strain, fatigue, headaches, stress and accidents. On the other hand, too much light can also cause safety and health problems such as "glare" headaches and stress. Both can lead to mistakes at work, poor quality and low productivity. Various studies suggest that good lighting at the workplace pays dividends in terms of improved productivity, and a reduction in errors. For example, in the ILO Manual, Improving Working Conditions and Productivity in the Garment Industry, it indicates that improved lighting in some factories resulted in a 10% increase in productivity and a 30% reduction in errors. Improvements in lighting do not necessarily mean that you need more lights and therefore use more electricity – it is often a case of:

- making better use of existing lights;
- making sure that all lights are clean and in good condition (see below);
- ensuring that lights are positioned correctly for each task; and
- making the best use of natural light.

Most factories have a combination of natural and artificial lighting. However, it appears that little attention is paid to the type of work – it is as though all work in the factory requires the same degree of lighting.

Improving lighting levels in the factory

Although there is often a need for shading windows to reduce heat inside a factory, there is also a need to make sure that all windows, skylights, etc., are clean and in the best position to allow the maximum amount of natural light into the workplace. Companies can always use appropriate shading methods for reducing the temperature – they should not rely on the windows being dirty.

Skylights and windows located higher up the factory walls let in a lot more light than lower windows which often get blocked with stock, raw materials, etc.

One simple way to improve the lighting levels in the factory is to paint the walls and ceilings with light, pale, matt colors. The use of matt paint avoids reflection of light which can lead to problems of glare. The color of equipment such as sewing machines, workbenches, etc., should normally be matched with that of the walls and black, shiny paints should be avoided. Brightening up the workplace helps to produce a more pleasant place to work which can impact on the workers' well-being and, ultimately, productivity.

Finding the best place for the light source

It may sound like common sense, but it is essential for the light to focus on the work at hand and not directly, or indirectly in the workers' eyes. The more detailed the task, the more light that is needed for the workers to carry out the job efficiently.

Figure: For close-up work, it is essential to have local lighting where the light shines directly on the task and not into the workers' eyes.

It is also essential that lights are positioned in the correct place so that workers do not have to adopt poor working postures to see the task at hand. It is also important to have adequate lighting near any potential hazards such as steps, ramps, etc., and outside the factory for security at night.

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Avoiding glare

Although lighting levels may be adequate in the factory as a whole, glare from a direct light source or reflected off equipment or shiny surfaces can cause discomfort, eye strain and fatigue, all of which contribute to an increase in errors, and a reduction in quality and productivity. Glare has been described as "light in the wrong place" and comes in three different kinds:

- Disability glare can dazzle and impede vision and therefore may be a cause of accidents. It is the result of too much light entering the eye directly
- Discomfort glare is more common in work situations. It can cause discomfort, strain and fatigue, especially over long periods. It is caused by direct vision of a bright light source and background.
- Reflected glare is bright light reflected by shiny surfaces into the field of vision.

Simple rules to avoid or reduce glare in the workplace

To reduce glare from windows

- use blinds, curtains, louvers, or shades;
- replace clear glass with opaque/translucent materials; paint glass with whitewash; and
- change the layout of workstations

To reduce glare from lamps

- ensure that no naked lights are in direct view of workers;
- raise the light fittings (if suspended) providing this does not reduce the overall level of lighting; and

- use shades or shields but ensure that the work area is well lighted.

To reduce reflected glare

- change position of the light source and reduce its brightness; •
- cover reflecting surfaces with opaque, non- glossy materials; and
- change the layout of the workstations.

How is light measured?

The level of light is measured in LUX using a light meter. The table below gives an indication of some typical light levels

Illuminance Example

- 1 lux Full moon overhead
- 50 lux Family living room
- 80 lux Hallway/toilet 100 lux Very dark overcast day
- 400 lux Sunrise or sunset on a clear day. Well it office area
- 1000 lux Overcast day, typical TV studio lighting
- 10,000-25000 lux Full daylight (not direct sun)
- 32,000-130,000 lux Direct sunlight

REMEMBER -Where possible, natural lighting should be used as preference over artificial lighting. Lighting should be sufficient to enable people to work, use facilities and move from place to place safely and without experiencing eye strain.

Simple rules for lighting

1. Make full use of daylight in the factory.

2. Choose appropriate visual backgrounds for walls, ceilings, etc.

3. Find the best place for the light source to avoid glare, etc.

4. Use the most appropriate lighting devices and fixtures.

5. Avoid shadows.

6. Ensure regular cleaning and maintenance of lights and windows.

Premises i.e. shop floor marking and safety

There are lot of importance of the floor for productive, smooth and safe work. Inappropriate floor surfaces, or poorly maintained floors, can be a major source of accidents, work interruptions and product damage. For garment producers, the floors should be flat to ensure stability of machines,

efficient and safe movement of workers and to ease the displacement of movable material handling equipment. The main floor technical properties are:

- Good compression resistance, to facilitate the movement of wheeled containers and mobile racks
- Good resistance to wear and abrasion, to avoid dust formation and to have sufficient resistance to withstand normal use over many years
- Very good ease of cleaning and washing
- Fairly good resistance to chemicals, particularly good oil resistance to avoid floor deterioration below sewing and other lubricated machines. Resistance to synthetic acid and disperse-dye solutions and pigments is also important.

The most convenient optional floor coverings are concrete, plastic and ceramic tiles. Floors which are frequently washed down with water should have an even gradient of 1-2 per cent towards a drain to ensure that the water flow away from the traffic area Carrying bully bundles on an uneven or slippery floor is a common cause of accidents. Transport surfaces can be covered or painted with high-friction coatings which reduce the risk of slipping but do not influence rolling resistance of carts and movable racks. Sudden height differences in passageways impede easy transport of containers and carts, and can cause accidents. Remove height differences and fill or bridge such places. If these obstacles are structural, provide gradually inclined covers so as to avoid stumbling or wheel barriers. Provide ramps to eliminate the need for steps or stairs, Ramps with a small slope between 5-8 percent greatly facilitate the transport of work items on carts. Make sure that the surface of the ramps is always dry, smooth and non-slippery. Non-slip pads and stripes should be used on stairs.

Building flexibility and adaptability plant layout:

During setting up or modernizing production facilities, it is the right time to improve space allocation, transport arrangements, production routes and the infrastructure of the building. Following a few rules will help to adapt the layout of workstations and storage areas to quickly organize production according to changing needs. It will also help to complete orders on time.

Reserving free space in the work area:

It needs to have reserved free space in the work area, otherwise it will quickly become overcrowded, with no space for extra tasks or increased production. This will help to avoid blockages of passageways. Space needed for additional machines in case of expansion or transfer of special machines for a particular process.

Allocating sufficient passageways:

Often in small garment enterprises, littlie care is taken to provide adequate passageways for efficient and safe movement of materials. In addition, passageways tend to become filled with bolts, bundles and containers. Passageways should be defined clearly; these can be marked, as well as work and storage areas, by drawing easily visible border lines of different colors. They can be painted or special marking tapes can be used. Make sure that everyone knows that the zones are to be respected.

Use production equipment and storage facilities which are easy to assemble and to dismantle: Always preference need to be given to equipment and storage units supplied in "modular kits" These enable to set up, move or replace a workstation in a very short time and with a minimum of disturbance to production.

Providing evenly distributed general lighting and supply circuits throughout the production area:

Since positioning of lighting is critical to the position of machines, both should be thought out thoroughly and simultaneously. When planning the layout of workshop it should be considered that the floor area required by work/activity sectors, circulation zones and storage areas. The required floor area of the most common workplaces like sewing, cutting, ironing and packing workstations, including chairs and storage containers, should be known and available when planning layout. The floor area needed and the quantity of racks, carts, pallets, containers, cabinets and buffers also need to be considered.

Hazardous substances and agents

Hazardous Substances are used in many workplaces and take many different forms. Solids, liquids, gases, mists and fumes can be present in the workplace. Exposure to hazardous substances can affect the body in many different ways. Skin contact, inhalation and ingestion can cause damage. In legislation, Hazardous Substances are defined in a number of ways. In The Control of Substances Hazardous to Health Regulations 2002 (COSHH), for example, they are those substances classified as toxic, very toxic, corrosive, harmful or irritant. Biological agents and dusts in substantial concentrations are also classified as hazardous substances.

Hazardous Substances can cause short- and long-term health problems. They can cause serious ill health including cancers, dermatitis and asthma. A cleaner splashing bleach on their skin could cause a burn or inflammation, which will have little long-term effect in most cases. However, a splash in the eye could cause permanent damage to their sight. A joiner suffering years of exposure to wood dust could have long-term health problems – the dust could affect his lungs and cause health problems for the rest of his life. There are legal obligations on employers to control exposure to Hazardous Substances to preserve the health of their employees.

Anyone who works with or is exposed to hazardous substances is at risk. Those exposed to more hazardous substances for long periods of time are more at risk than those exposed for short periods or to less hazardous substances.

The aim should be to prevent exposure to hazardous substances. Where exposure cannot be avoided, then adequate controls should be put in place.

Assessing risks from Hazardous Substances in your workplace

The risks associated with the hazardous substances present in your workplace must be assessed. The employer has the responsibility for the risk assessment. They may call on assistance if it is required.

The person conducting the assessment must have a knowledge and understanding of the process and the requirements of the COSHH regulations. Make use of the existing knowledge within the work-place before deciding whether outside assistance is needed.

Most simple assessments can be carried out in-house:

- make a list of all the substances and products in the workplace
- gather as much information as you can on each substance and the risks associated with them
- look at information on labels, in suppliers' catalogues and material safety data sheets.

You then need to assess how these risks relate to the specific circumstances of your workplace. Con-sider:

How much of each substance is used and how often? Larger quantities or substances that are used often will increase the risk of exposure.

How is each substance used? Are the substances mixed, poured, sprayed, piped, heated, cooled, etc.? The way they are used will determine how you will control exposures.

How could people be exposed and what effect could it have on their health?Is the substance a solid, liquid, gas, mist or fume? Will the substance damage their skin, lungs, eyes through skin contact, absorption, ingestion, inhalation or injection?

Answering these questions will help you carry out the risk assessment and determine the measures you need to take to protect the health of those people who could be exposed.

Good practice around Hazardous Substances

The COSHH Approved code of Practice (ACoP) recommends that exposure be prevented by:

- altering work methods so that the task that causes exposure is no longer carried out
- modifying the process to remove Hazardous Substances including by-products or waste
- substituting the hazardous substance with a less hazardous type or form of the substance, e.g. using granules instead of powder to reduce dust levels or a less volatile solvent in a process.

If exposure cannot be prevented, it must be adequately controlled. The hierarchy of control measures can be summarised as follows.

Eliminate: Don’t use the hazardous substance or avoid the procedure which causes exposure.

Substitute: Change the material or working practice to one less hazardous.

Enclose: Enclose the hazardous substances or process in a closed system.

Control: Control exposure to the hazardous substance by using one of the following methods:

- Engineering Controls: Control the exposure at source with local exhaust ventilation or in-creased dilution ventilation to lower concentrations in the atmosphere.

- Procedural Controls: Reduce the numbers exposed or the time spent on the procedure, carry it out in specified areas and carry out routine monitoring and health and medical surveillance if needed.
- Personal Protective Equipment: Provide gloves, impervious aprons or overalls and/or respiratory protection to minimise the effects of exposure to hazardous substances.

Information, instruction and training

Provide everyone who is involved with, or could be affected by the use of hazardous substances with the degree of training, instruction and information required to ensure their safety.

Emergency procedures

It is also important to put in place procedures to cope with accidents and emergencies.

The controls you have in place may be adequate for normal activities but what would you do if there were an emergency like a major spillage or release of a substance?

It is vital that there are contingencies to deal with these circumstances.

Checklist for Hazardous substances and agents

1. Isolate or cover noisy machines or parts of machines.

2. Maintain tools and machines regularly in order to reduce noise.

3. Make sure that noise does not interfere with verbal communication and auditory signals.

4. Reduce vibration affecting workers in order to improve safety, health and work efficiency.

5. Choose electric hand-held equipment that is well insulated against electric shock and heat.

6. Ensure safe wiring connections for equipment and lights.

7. Label and store properly containers of hazardous chemicals to communicate warnings and to ensure safe handling.

8. Protect workers from chemical risks so that they can perform their work safely and efficiently.

9. Identify confined spaces requiring entry permits and take adequate control measures to render the space safe for entry and work.

10. Protect workers from biological risks by minimizing exposure to biological agents and isolating potentially contaminated areas.

Work organization i.e. job rotation and multiskilling

Work organization is about the control of work and the division of labor. It includes the tasks performed, who performs them and how they are performed in the process of making a product or providing a service. Many workplaces are undergoing massive changes in the ways in which work is organized, often made possible by innovations in information and communications technologies. New forms of work organization, such as combined jobs, multi-tasking, teams, telecommuting, electronic performance monitoring, use of temporary workers, contract workers and alternative work schedules, are being introduced with very little attention to their potential to hurt workers. However, we do know that these forms of work restructuring can increase workers' risk of injuries, illnesses and stress.

The organization of work includes many aspects, such as pace of work (speed of an assembly line, quotas), work load, number of people performing a job (staffing levels), hours and days on the job, length and number of rest breaks and days away from work, layout of the work, skill mix of those workers on the job, assignment of tasks and responsibilities, and training for the tasks being performed. When work is restructured, these aspects of work organization can be changed dramatically. Work is restructured by management to achieve the goals of standardization of the work, which in turn is used by management to increase their control over work.

Some common terms for work organization/reorganization include:

• **Lean Production**: An overall approach to work organization that focuses on elimination of any "waste" in the production/service delivery process. It often includes the following elements: "continuous improvement", "just-in-time production", and work teams.

• **Continuous Improvement**: A process for continually increasing productivity and efficiency, often relying on information provided by employee involvement groups or teams. Generally, involves standardizing the work process and eliminating micro-breaks or any "wasted" time spent not producing/serving.

• **Just-in-Time Production**: Limiting or eliminating inventories, including work-in-progress inventories, using single piece production techniques often linked with efforts to eliminate "waste" in the production process, including any activity that does not add value to the product.

• **Work Teams**: Work teams operate within a production or service delivery process, taking responsibility for completing whole segments of work product. Another type of team meets separately from the production process to "harvest" the knowledge of the workforce and generate, develop and implement ideas on how to improve quality, production, and efficiency.

• **Total Productive Maintenance:** Designed to eliminate all nonstandard, non-planned maintenance with the goal of eliminating unscheduled disruptions, simplifying (de-skilling) maintenance procedures, and reducing the need for "just-in-case" maintenance employees.

• **Outsourcing/Contracting Out**: Transfer of work formerly done by employees to outside organizations.

In many workplaces undergoing restructuring, worker knowledge about the production/service process is gathered through" employee involvement" and then used by management to "lean out" and standardize the work process, thereby reducing reliance on worker skill and creativity. This restructuring has resulted in job loss for some workers, while increasing the work load and work pace for those who remain on the job. The result of these changes in work organization is that it is no longer just machines that are wearing out – it is the workers themselves.

Checklist for work organization

1.Solve day-to-day work problems by involving groups of workers.

2.Consult workers on improving working-time arrangements.

3.Involve workers in the improved design of their own workstations.

4.Consult workers when there are changes in production and when improvements are needed for

safer, easier and more efficient work.

5.Inform and reward workers about the results of their work.

6.Train workers to take responsibility and give them the means to make improvements in their jobs.

7.Train workers for safe and efficient operation.

8.Provide up-to-date training for workers using computer systems.

9.Provide opportunities for easy communication and mutual support at the workplace.

10.Consider workers' skills and preferences in assigning people to jobs and providing them with opportunities to learn new skills.

11.Set up work groups, each of which collectively carries out work and is responsible for its results.

12.Improve jobs that are difficult and disliked in order to increase productivity in the long run.

13.Combine tasks to make the work more interesting and varied.

14.Set up a small stock of unfinished products (buffer stock) between different workstations.

15.Assign responsibility for day-to-day cleaning and housekeeping.

16.Provide short, frequent pauses during continuous precision or computer work to increase productivity and reduce fatigue.

17.Provide opportunities for physical exercise for workers.

18.Encourage full participation by women and men workers in finding and implementing work improvements.

19.Assist migrant workers to perform their jobs safely and efficiently.

20.Assign appropriate workload, facilitate teamwork and provide adequate training for young workers.

21.Adapt facilities and equipment to workers with disabilities so they can do their jobs safely and efficiently.

22.Give due attention to the safety and health of pregnant and nursing women.

23.Take measures so that older workers can perform work safely and efficiently.

24.Adjust the workplace to the culture and related preferences of workers by taking a user-centred

approach.

25.Involve both managers and workers in conducting ergonomics-related risk assessment as part of occupational safety and health management systems.

26.Establish emergency plans to ensure correct emergency operation, easy access to facilities and rapid evacuation.

27.Learn about and share ways to improve your workplace from good examples in your own enterprise or in other enterprises.

Appendix 7: Research data sampling

Basic company data

The basic information of the companies is presented in the following tables. All data to be entered in excel spreadsheet.

Date	
Responsible researcher	
Other researchers	

Company information

Name of company	
Ownership	
EPZ/Ownership	
Headquarter address	
Webpage	
Foundation	
Number of production sites	
% export	
Production capacity (Maximum number of units produced in one shift under normal conditions of machines and workers)	

Production site

Name	
Address	
General manager (name, email, tel)	

Departments/structure	How many departments/units and the name of each department/unit
Description of facilities (buildings, area, stories)	
Production capacity (Maximum number of units produced in one shift under normal conditions of machines and workers))	
Main costumers	
% utilization of capacity	
Certificates	
Membership of business associations	
Unions/committees	

Main products of the site (no of pieces)	Last Year	Current year + projection
Comments		

Employees of the site	Last year	Current year + projection
Total (incl. all categories)		
- male		
- female		
Shop floor workers (production)		
Managers and production staff		
HR and safety staff		
Quality assurance staff		
Comments		

Accidents	Last year	Current year + projection
Total no. of accidents		
Comments		

Turnover and absenteeism	Last year	Current year + projection
Turnover in % (annually)		
Absenteeism in % (annually including with and without leave)		
Comments		

Productivity	Last year	Current year + projection
Standard main product		
Units/minutes (SMV)		
Units/worker/hour		
Comments	Standard product is the basic product (Basic shirt, Basic T-shirt and Basic pants). SMV is Standard Minute Value.	

Quality	Last year	Current year + projection
Employees		
% of products with quality defects		
% of Remaking (Total defects less Rejected)		
% no of products scrapped or rejected by quality control		
Acceptance quality limit (AQL)		
Comments		

Salaries and working hours for shop floor workers	
Lowest salary	
highest salary	
Average salary	
Normal working hours daily	
Average number of overtime hours daily	
Number of shifts	

Template for log book

All contacts and events in the factory entered in the logbook (telephone, meetings, trainings, informal talks, interviews etc). Data entered everyday after work or contact with company. See examples below.

Company name:				
Observation object	Description of observed occurences	Persons present	Written by	Date
Telephone	Talked to contact person about organisation of next meeting	Name: contact person and AUST reseearch	Name of Aust researcher	xx.xx.2017
Training of operational team	Three hours training of operational team in xx department. Participation of xxxxx. See separate programme. Active participation of xxxx, more passive xxxx workers, xx suggestions for improvements etc. etc.	Department head, line supervisor, quality controller, three senior workers	Xxx	xxx
KPI measurement	Who doing measurements of xxxxx. Talked to line supervisor who had difficulties in understanding the project, talked to several workers who were very informative……..etc. etc.	The case line in department xxxx		

Interview guide for introductory interviews

See baseline methodology for interview guides for maturity assessment. In case of companies participating in baseline study, key persons are interviewed about changes since last visit.

				Version 02.11.2015
Interview OHS manager				
Dimension	Evidence			
	Data	Documentation	Informants	Observation
	The OHS Maturity Assessment			
Leadership commitment and communication	The number of OHS programmes / Initiatives initiated and championed by top management / Number of health and safety projects initiated by employee suggestions	Descriptions of OHS improvement programmes (team composition, actions, outcomes) / Policy about dealing with employees involved in accident / Meeting minutes / memos of health and safety meetings where employees suggestions for health and safety improvement are noted and acted upon	What do you do after an accident? What happens to the employees involved in severe accident? What kind of safety communication do you use? Normally and after an accident?	
Business Policy	Type and number of awards / List of receivers of safety awards	Policy, Memo or minutes of meetings outlining the decision process and actions related to safety investments / Safety Award programme description (who is awarded? What is the criteria for awards?)	What types of investment in OHS has been done? What kind or recognition or rewards for safety do you have?	
Relation with contractors	The number of pre-qualified contractors / Total of	Prequalification questionnaire for contractors	Do you have contractors? What kind of prequalification	

	contractors / Total of audits / Audits per contractor	/ Training for contractors / Auditing process and resources/audits carried out and consequences taken	OHS criteria you look at?	
Relation with buyers	The number of direct and indirect buyers / Duration of relationship / Percentage of total revenues or sales per buyer / Total of audits / Audits per buyer	Prequalification questionnaire of buyers / Training by buyers / Auditing process (auditing items, penalties, corrective actions, resources)	Can you describe the relation with your main buyers?	
Objectives, Targets & Performance Measurement	Number of safety indicators (proactive and reactive / outcomes and process indicators) / Trends and charts of safety indicators	List of safety indicators and objectives / Owners of indicators / Process of monitoring and review	Do you have safety targets? What safety indicators and target do you have? Who is involved in establishing and improving safety targets?	Look for visual safety indicators in the workplace
Training	Number of trained employees and managers	Documentation for training (new employees, managers, safety professionals, office workers, shop floor workers)	What are the safety trainings you have? What is the aim of these training modules? How you identify needs for training?	Look at the quality and availability of health and safety training facilities and equipments
Workforce Involvement	Number of employees from each department engaged in safety initiatives (safety department, production, managers and workers)	Committees with worker participation (actions and outcomes) / Description of OHS work planning and the review process / Participants in the planning and review / Policy for risk analysis (participants / impacts on operations/ implemented risks assessments / List of items checked and description of the process of daily checks / participants / impacts on operations)	What the safety ongoing initiatives? Do you have OHS planning? Do you have safety committees? Do you have daily checks? How is it done?	Look at the software or other techniques used for risk analysis
OHS structure and accountability for OHS results	Number and seniority of people in the safety department / Turnover of OHS employees	Description of OHS responsibility in the company / Policy or minutes describing the accountability of managers and workers for OHS results and control.	What is the structure of safety? Who is responsible for following up on accident issues?	
Accident Investigation	Number of accidents investigated / Outcomes / Impacts	Description of the process for investigation of accidents (responsible for investigation and maintenance)	Do you have investigation process? Can you describe the process? Outcomes and follow up?	Look at the implementation and outcomes
Unsafe Behaviors and Unsafe Work Conditions	Number and types of unsafe behaviors and unsafe work conditions / Severity	Description of the process of reporting and improvement	What are the unsafe behaviors and unsafe work conditions? How do you report unsafe behavior and unsafe working conditions?	

Legal requirements, Auditing and Reviews	Number of critical and urgent issues in audit	Description of audit system / Latest regulatory assessment / Action plan	Please describe the auditing process and types	
Industrial relations, Welfare and Job Satisfaction	Number of employees using companies benefits / Type of benefits used	Description of the benefits policy	What are the benefits you have? How is the satisfaction with the benefits?	Look at the quality of the services (Medical Centre, Canteen, Childcare, Dormitories…)

Interview Production manager				
Dimension	Evidence			
	Data	Documentation	Informants	Observation
	The Lean Maturity Assessment			
Leadership commitment	Number of full time lean employees or equivalent / Seniority level / Years of lean experience / Number of managers experts in lean/improvement	Projects and improvement documentation	What are the lean/improvement initiatives? Who participate in the projects? Who is the driver of the projects?	
Employee involvement	Number of improvement suggestions (Total / implemented/outcomes) / Number of employees participating in group projects	Description of the employees suggestions program / Documentation of group projects/teamwork and participants	Do you have an improvement process? Who is involved in improvement?	
Training	Number of trained employees (shop floor / staff / Managers) / Number of hours training by employee	Description of type of training available (basic, specialists, technical, behavioral)	What types of improvement training do you have? How do you identify the need for improvement training?	
Continuous improvement	Data showing number and type of errors / trends in errors / number of SOP	Description of problem solving methods based on use of data and performance indicators	Explain how you measure errors/defects and improve the process. Do you have SOP? How is SOP used? Who is involved in continuous improvement?	Look for SOP at the production line / Look for error proofing devices in the production line. Look for implemented improvements
Value stream mapping	Number of mapped value steam processes / outcomes	Maps and description of value stream processes	Do you use value stream mapping? How do you use VSM?	Look for the maps of value stream processes
Control through Visibility	Number of techniques/ Number of units using visual management techniques	Description of the objectives and implementation of visual management tools	Do you use visual management? What tools of visual management? How do you use the tools? What are the benefits?	Look for visual instruments in the shop floor and offices
Accounting support to Lean	Accounting data supporting lean/improvement activities		Do you use accounting information for improvement?	
5S/housekeeping	Number of areas with 5S implemented and status of implementation	Description of 5S project	Do you use 5S? What are the status and the challenges of 5S?	Look at the 5S status on the shop floor and staff offices

Preventive maintenance	Number of employees trained in preventive management/data used for preventive maintenance	Preventive maintenance policy	Do you have preventive maintenance? How it works? Who does the preventive maintenance?	Look at the preventive maintenance schedules and devices at the shop floor
Structured Flow/Pull Manufacturing	Data about Takt time (= Production time available / Customer volume) / inventory level		Do you use flow or takt-time concepts? Do you use U shape or other shapes?	Look at the production line for inventories/Kanban/flow/U-shape/Cells/Pull
Customers and Suppliers relationships	Performance Indicators with suppliers and customers	X	What type of cooperation for production improvement do you have with your suppliers/customers? Are there sharing of experiences and risks?	

Quality manager	
Interview topics	
Structure and organization of quality control	Number of quality managers and supervisors, technical and admin involved
Quality management and control	Control items (size of the product, quality of the work)/ quality management by looking at wastes, reworks, rejections. (Measures like 3 sigma or 6 sigma; hypothesis testing such as t test or Chi square etc…; What is the process in case of rejections or defects? / Quality tools and techniques (form groups for investigation, look at numbers and statistics, use fishbone or PDCA)/ Error proof devices (if error above the acceptable limit, does the device shut the machine?)
Quality KPIs (Benchmark)	% of defects, time used for rework, value of scrapped products
Training in quality	Types of training (technical training like measurements or machine adjustments, tools like root cause analysis, use of numbers and statistics, understanding of variations and trends) / Number and level of trained employees (new employees, experienced quality controllers or inspectors, training for quality supervisors and managers)/ policy of training (automatic or according to needs)
Quality certifications	ISO 9001, others / what is the meaning of these certifications for the company? Is this for the buyers? Or workers involvement and motivations? Have these certifications impacted quality and productivity?
Suppliers	Quality control of supplies (what happens if the quality of supplies is not good?), indicators (on time delivery, quality of supplies, price of supplies versus quality), new products from suppliers
Buyers	management of customer demands (sampling, PP(pre-production), production; time and quality for the acceptance process), indicators (time and quality), customer audits, new techniques (sometimes buyers support or provide the technology)
Challenges and expectations	quality challenges (new customers or new styles), expectations and plans for future development of quality control and management / future certifications

Employees (focus group)	
Interview topics	
Experience with production and quality	Examples of production constraints and quality problems. Ideas for improvement
Experience with OHS and HR	Examples of OHS problems and HR problems (salaries, hours, benefits etc.). Ideas for improvement
Involvement in improvement of production and OHS	Examples of involvement, participation, process and outcomes, collaboration with supervisors
Training	Production, quality and OHS
Accidents	Examples of accidents, Investigation, follow up prevention and impact on workers
OHS policy practice	OHS checks / risk assessment / Reporting accidents / unsafe conditions / rewards
Benefits and services	Use / satisfaction

General manager of site	
Interview topics	
History	Main historical information about site and company
Growth (Investments / hiring)	Future or planned investments and hiring
Challenges	External and internal challenges
Strategic advantages	Competition / capabilities / Technology
Buyers	Relation and impact on business, collaboration (long term relationship, trust, commitment or shopping around)
Compliance	Compliance/OHS versus Productivity
Productivity or Lean	Tools and philosophy for increasing productivity
Employee satisfaction and turnover	Scores and actions

Interview guide for follow up interviews

All involved persons should be interviewed about their assessment of both process and outcome of the intervention.

The following topics or questions should guide the interview after the intervention to assess the process and the outcome of the intervention. The interviewees are General Manager, Production Manager, Quality Manager, Compliance Manager, Core Team, Supervisors, Representant of Workers, Safety Committee members.

- Please comment on the positive outcomes and activities of the intervention
- Please comment on the aspects that could be done differently (different activities, more time, change process of implementation, involve more people, more training)
- Can you notice change in productivity?
- Can you notice change in OHS conditions?
- Do you think that you can continue this process without external support?

Template for interview summaries

Date and duration of interview	
Responsible for writing the summary	
Other participating researchers	
Interview person(s) (position, main tasks, name, education, seniority)	
Summary of interview	
	(to be continued on as many pages as necessary)

Template for data entry on KPI (missing)

(N.B For more detail, refer to files "Diagnosis tools for lean" (excel), "Time study training" (pdf), and VSM (excel) in Intervention/Training folder)

Template for OHS KPI

OHS Quantitative KPI (line level) – The unit is number *1.General Information:* *a. Line No:* *b. Company name*					
KPI's	**Date of Ob-serv.1**	**Date of Ob-serv. 2**	**Date of Ob-serv. 3**	**Date of Ob-serv. 4**	**Date of Ob-serv. 5**
Absenteeism					
Accidents (Injuries)					
Occupational sickness					
Employee Turnover					
Comments					

OHS Quantitative KPI (Workstation level) – The unit is number *1.General Information:* *a. Line No:* *b. Workstation no:* *c. Company name*					
KPI's	**Date of Ob-serv.1**	**Date of Ob-serv. 2**	**Date of Ob-serv. 3**	**Date of Ob-serv. 4**	**Date of Ob-serv. 5**
Light					
Noise					
Temperature and Humidity					
Dust					
Comments					

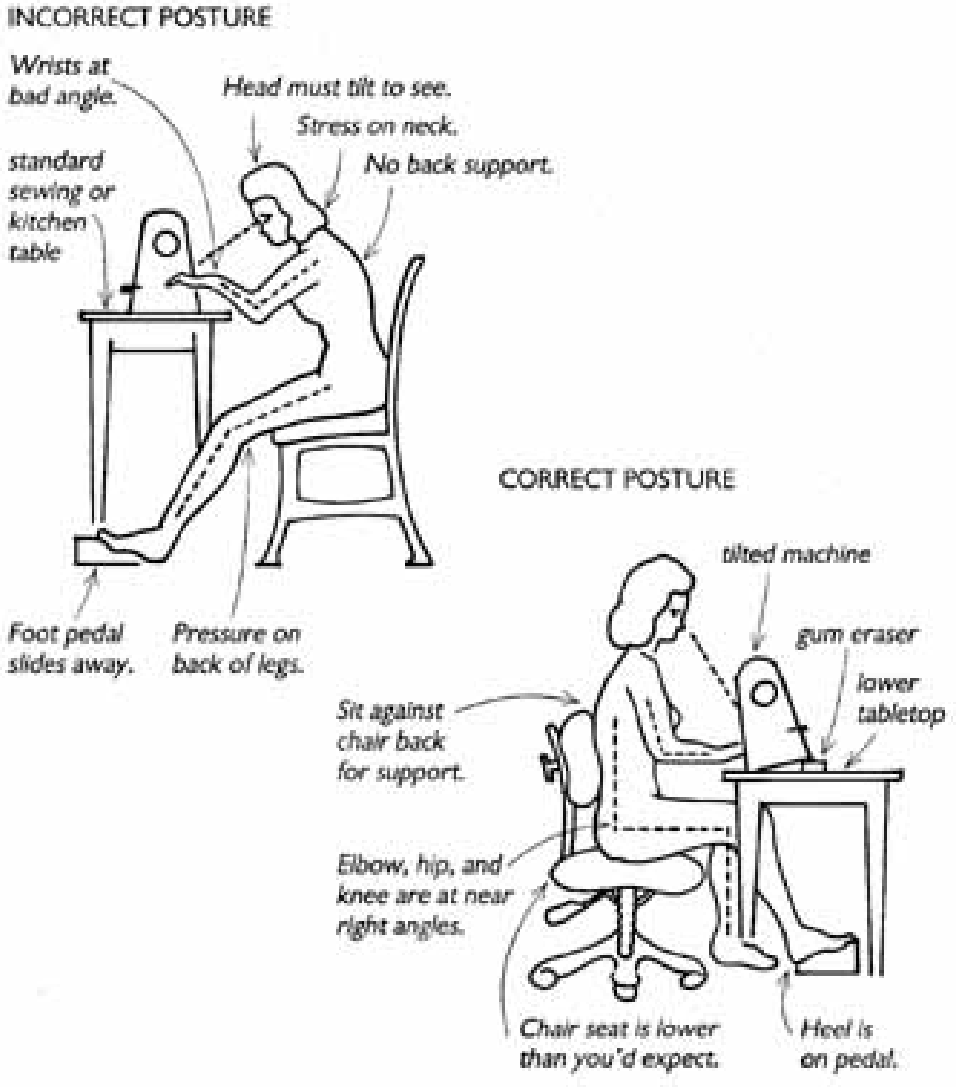
Ergonomics and OHS assessment / Work satisfaction questionnaire

OHS Quantitative KPI (Workstation level) – The unit is number *1.General Information:* *a. Line No:* *b. Workstation no:* *c. Company name*					
KPI's	**Wkt.1**	**Wkt.2**	**Wkt.3**	**Wkt.4**	**Wkt.5**
Light					
Noise					
Temperature and Humidity					
Dust					
Comments					
Instruments are used to measure these KPI's at the workstation level. Since we don't have equipment for measuring Dust, then Dust is assessed as Acceptable (A) or Need Improvement (NI)					

Ergonomics and OHS assessment (workstation level)

Ergonomics (workstation level) – Part 1/2 *1.General Information:* *a. Line No:* *b. Workstation no:* *c. Company name*					
Please refer to the pictures in order to assess the item as Acceptable (A) or Needs improvement (NI)					
Assessment level	**Wkt.1**	**Wkt.2**	**Wkt.3**	**Wkt.4**	**Wkt.5**
Head Position					
Arm Position					
Back Position					
Leg position					
Comments					


Work surface height
should be around
elbow level
Work surface
thickness
5 cm maximum
66 - 72 cm
min
40 cm
Thigh clearance
20 cm maximum
Seat height
34 - 45 cm
(adjustable to
each worker)


INCORRECT POSTURE
Wrists at
bad angle.
Head must tilt to see.
Stress on neck.
No back support.
standard
sewing or
kitchen
table
Foot pedal
slides away.
Pressure on
back of legs.
CORRECT POSTURE
tilted machine
gum eraser
lower
tabletop
Sit against
chair back
for support.
Elbow, hip, and
knee are at near
right angles.
Chair seat is lower
than you'd expect.
Heel is
on pedal.

OHS assessment (workstation level) – Part 2/2

1.General Information:

a. Line No: *b. Workstation no:*

c. Company name

On a scale of 1-5 (1 lowest and 5 highest), please rate the following:

	Wkt.1	**Wkt.2**	**Wkt.3**	**Wkt.4**	**Wkt.5**
Easy reach of materials (refer to fig. 1)					
Enough space (Refer to fig. 2)					
Machine safety: 1- Belt cover 2- Needle guard* 3- Eye guard 4- Machine light All 4 items corresponds to score 5, 3 items to score 4, 2 items to score 3, 1 item to score 2, and 0 item to score 1.					
Housekeeping (clean and clear)					

Comments

Housekeeping	1	No housekeeping: factory and offices are messy dirty	
	2	Some places in the factory and offices are messy and dirty	
	3	Factory and offices are clean but messy	
	4	Factory and offices are clean and tidy	
	5	Factory and offices are very clean, organized and tidy	

* Check the type of machine to assess if “Needle guard” is applicable

Health assessment (workstation level)

1.General Information:

a. Line No: *b. Workstation no:*

c. Company name

Please write Yes or No

	Wkt.1	Wkt.2	Wkt.3	Wkt.4	Wkt.5
Use mask					
Use ear plug					
Comments					

Figure 1

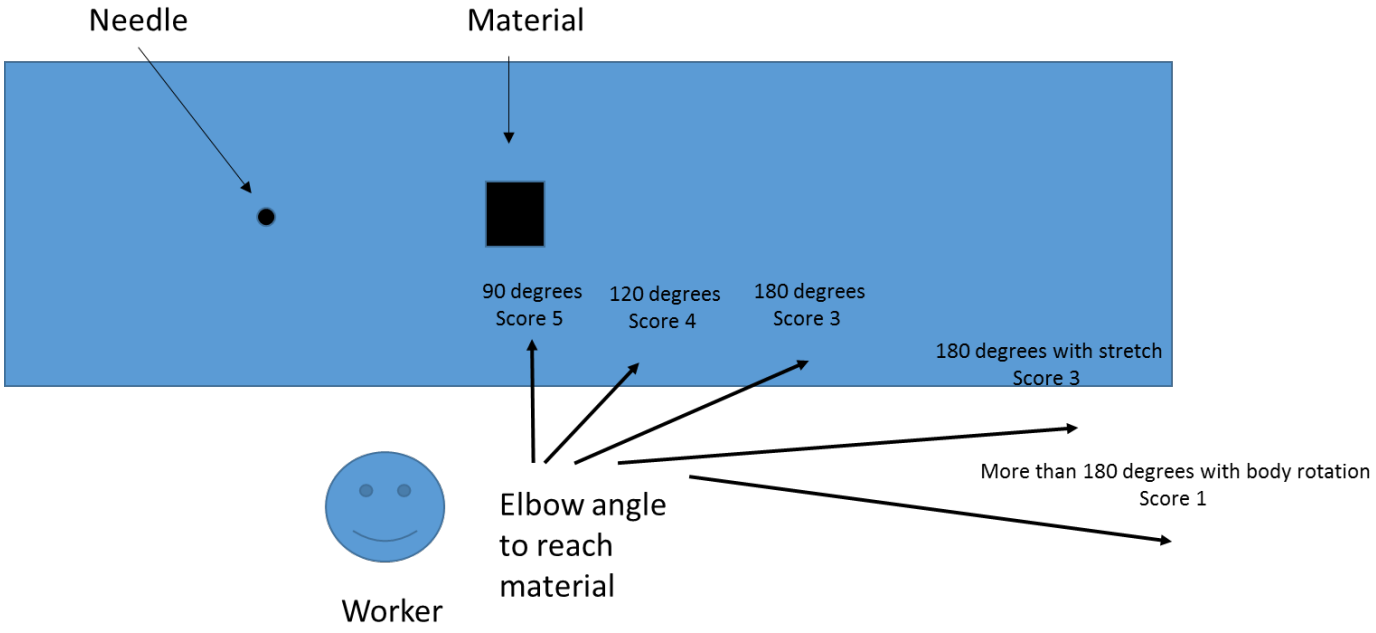
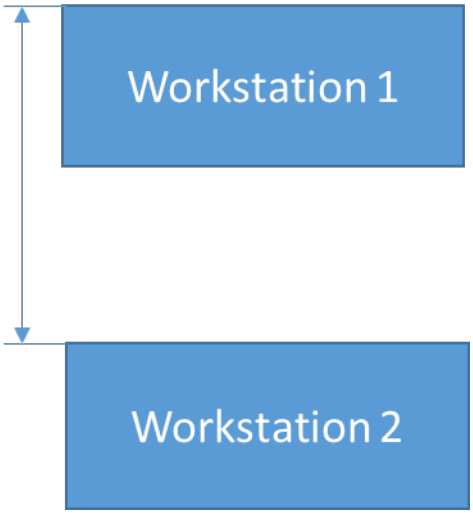


Figure 2

Distance between worsktations	Score
44”	5
44” + 12”	4
44” + 18”	3
44” + 24”	2
44” + more than 24”	1



Worker's perception questionnaire

Worker perception questionnaire (Part 1/4)					
1.General Information: *a. Job:* *b. Age:* *c. Job seniority* *d. Company name*					
On a scale of 1-5, please rate according to the following: *1-Very unsatisfied; 2-Unsatisfied; 3-Neutral; 4-Satisfied; 5-Very satisfied*					
Satisfaction level	Wkt.1	Wkt.2	Wkt.3	Wkt.4	Wkt.5
How much are you satisfied with your present job?					
How much are you satisfied with your present work organization?					
How much are you satisfied with your work environment/conditions?					
How much are you satisfied working with your supervisor?					
How much are you satisfied with your skill level?					
What is your overall satisfaction level?					
Comments					
If No, please comment here					

Worker perception questionnaire (Part 2/4)					
Please answer Yes or No					
Participation and Voice behavior:	Wkt.1	Wkt.2	Wkt.3	Wkt.4	Wkt.5
Can you identify any problem or propose any suggestion related to your work?					
Do you raise any suggestion for work related problems or work improvement to your supervisor or manager?					
Do your supervisor or manager willing to hear your problems or suggestions?					
Do you hesitate to raise problem or suggestion?					
Do you find any barrier to raise your voice to the supervisor or manager?					
Do the supervisor or manager addresses your problem or suggestion?					
Comments					
If No, please comment here					

Worker perception questionnaire (Part 3/4)					
Please answer Always (A), Sometimes (S), Never (N)					
Health	Wkt.1	Wkt.2	Wkt.3	Wkt.4	Wkt.5
Do you feel any discomfort to work here?					
Do you feel any fatigue after work?					
Do you feel any pain in arm, neck or shoulder during and after work?					
Do you feel safe at work? (eye injuries, cutting fingers or other safety issues)					
Do you feel any pain in back due to work?					
Do you feel any pain in legs due to work?					
Comments					

Worker perception questionnaire (Part 4/4)					
Please answer Yes or No					
Workstation	Wkt.1	Wkt.2	Wkt.3	Wkt.4	Wkt.5
Do you feel any stress to work here?					
Does the chair fit with you?					
Are you comfortable with the height and size of the table?					
Do you feel any problem with the lighting?					
Do you feel any problem to collect item from your neighboring fellow employee?					
Do you feel any problem to drop item to your neighboring fellow employee?					
Do you inform the inconveniences you feel to work with the workstation to your supervisor or manager?					
Comments					
If No, please comment here					

Guidelines for OHS assessement

Name of line/department	
Date of observation	
Participating site staff (position, main tasks, name, education, seniority)	
No of workers	
No of supervisors	
Production equipment	Number of workstations and machines
Main products	
Output/hour or day (Takt time)	

Scoring 1-5, NA (1=conditions poor/risks not controlled/low productivity/not existing, 3=conditions acceptable, risks controlled/productivity as expected, present at expected level, 5=conditions good, risks avoided at high level, productivity high, present at best level, NA=not applicable)

Item	Score	Description of Selection Criteria
Machine risks (physical protection and behaviour)	1	High risks with inadequate protection and inadequate behaviour
	2	Medium risk with protection but risky behaviour
	3	Low risk with good protection but risky behaviour
	4	Low risk with good protection and safe behaviour
	5	Very low risk and state of the art protection and safe behaviour
Chemical risks	1	High chemical risk with inadequate protection
	2	Medium chemical risk with adequate protection
	3	Low risk with adequate protection
	4	Low risks with good protection
	5	Very low chemical risk with state of the art protection
Vapours and Dust	1	Intense vapour and dust
	2	Medium tolerable vapours and dust
	3	Low level of vapours and dust
	4	Automatic control of vapours and dust levels
	5	Clean factory with state of the art control
Noise	1	High noise with no protection
	2	Medium noise with no protection
	3	Medium noise with good protection
	4	Low noise with good protection
	5	Low noise with state of the art protection
Housekeeping	1	No housekeeping: factory and offices are messy dirty
	2	Some places in the factory and offices are messy and dirty
	3	Factory and offices are clean but messy
	4	Factory and offices are clean and tidy
	5	Factory and offices are very clean, organized and tidy
Lighting	1	Inadequate level of lighting across offices and shop floor
	2	Some places of shop floor and offices have bad lighting
	3	Adequate lighting in shop floor and offices
	4	Automatic lighting in shop floor and offices
	5	Automatic and adjustable lighting in shop floor and offices
Layout (easy access, unnecessary movements and transport avoided)	1	Layout is messy with difficult access and unnecessary transport
	2	Some places in shop floor have difficult access with unnecessary movement
	3	Access and transport are acceptable with no big obstacle
	4	Layout is easy with access and transport
	5	Layout is integrated with easy access and automatic transport
Heat	1	Very hot shop floor and offices
	2	Very hot in some places in the factory

	3	Regular temperature most of the time
	4	Regular temperature even in the very hot summer
	5	Adjustable temperature all year round
Ventilation	1	No Ventilation
	2	Small ventilators on the walls or celling
	3	Big ventilators on the walls
	4	Big ventilators with flow and speed adjustment
	5	Air condition
Floor marking of transport and production areas	1	No floor marking
	2	Floor marked partially
	3	Floor marked completely
	4	Floor marked completely and containing wide passage
	5	Floor marked completely with wide passage and sign direction
Smooth floor without holes	1	Big holes in the floor
	2	Some small holes on the floor
	3	Shop floor and offices with smooth floor
	4	No holes with anti-slippage cover on the floor
	5	No holes with bright, anti-slippage and anti-shock cover
Chairs with backrest and height adjustable	1	Non-suitable and non-adjustable chairs
	2	Some adjustable chairs <25%
	3	Adjustable Chairs with adjustable backrest > 50%
	4	Adjustable Chairs with adjustable backrest > 75%
	5	Adjustable Chairs with adjustable backrest =100%
Tables/machines in good height and adjustable	1	Tables/Machines are non-adjustable
	2	Some adjustable Tables and Machines <25%
	3	Adjustable Tables and Machines > 50%
	4	Adjustable Tables and machines > 75%
	5	Adjustable Tables and Machines =100%
Materials and tools within easy reach	1	Materials and tools with difficult reach
	2	Some materials and tools with difficult reach
	3	Materials and tools within reach
	4	Materials and tools within reach and marked area
	5	Materials and tools within easy reach, marked area and basic instructions for use
Equipment for heavy lifting and carrying (lifts, carts, etc.)	1	Not available
	2	Very limited use for very heavy loads
	3	Equipment for heavy lifting are available for daily use
	4	Equipment for heavy lifting are built in the building
	5	Automatic heavy lifting equipment built in the building and available on the shop floor.
Standard of machinery and equipment (age, maintenance)	1	Old machinery with constant need of maintenance
	2	Some new machinery <25%
	3	New machinery >50%
	4	New machinery >75%
	5	New machinery =100%

Standard of machinery and equipment (Technology)	1	Out-dated technology
	2	New technology <25%
	3	New technology >50%
	4	New technology >75%
	5	New technology =100%
Flow (line balancing, buffers, additional helpers)	1	No line balancing with lot of inventory between work-stations
	2	Some machines have inventory and additional helpers
	3	Line is balanced 50% of the time
	4	Line is balanced > 75% of the time
	5	Line is balanced 100% of the time with various techniques (Kanban, Flexible manufacturing)
Kanban	1	No use of kanban
	2	Some limited use in < 25% of production lines
	3	Kanban is used in >50% of the production lines
	4	Kanban is used in >75% of the production lines
	5	Kanban is used in 100% of the production lines
SOP for machines	1	No SOP
	2	SOP available for some workstations
	3	SOP available and used for >50% of the stations
	4	SOP available and used for >75% of the stations
	5	SOP available and used for >100% of the stations
Daily/weekly production performance displayed	1	No daily or weekly planning
	2	Daily or weekly planning performance displayed but not updated or used
	3	Daily and weekly planning displayed, but not frequently used
	4	Daily and weekly planning displayed and used
	5	Daily and weekly planning displayed, updated and used
Quality defects display	1	No quality defects displayed
	2	Quality defects displayed partially but not updated
	3	Quality defects displayed, but not frequently updated or used
	4	Quality defects displayed and used but not frequently updated
	5	Quality defects displayed, updated and used
Accidents and incidents displayed with actions	1	No accidents/incidents displayed
	2	Accidents and incidents displayed partially but not updated
	3	Accidents and incidents displayed, used but not frequently updated
	4	Accidents displayed and used but not frequently updated
	5	Accidents displayed, updated and used
Kaizen boards	1	No kaizen boards for improvement
	2	Some kaizen boards but not updated

	3	Kaizen boards available across the factory but not all updated
	4	Kaizen boards available and updated by supervisor
	5	Kaizen boards available and updated by workers
OHS labels and posters	1	No OHS labels or posters available
	2	Some OHS labels and posters available but not updated
	3	OHS labels and posters available across the factory but not all updated
	4	OHS labels and posters available and updated by compliance officer
	5	OHS labels and posters available and updated by workers
Access to drinking water	1	No drinking water available
	2	Access to drinking water not easy
	3	Easy access to regular drinking water
	4	Cold and regular drinking water available
	5	Mineral drinking water available
Toilets	1	No toilet facilities
	2	Dirty toilet facilities for males and females
	3	Clean toilet facilities for males and females
	4	Separate toilet facilities available in different places in the factory
	5	Separate clean toilets with clean shower

Specific data sampling for the three Phd studies

Abu specific data sampling needs

There are number of KPIs that can be measured but you may not be needed to measure them all. Number of KPIs to be established in a garment production unit will depend on things a factory wants to measure. You have to decide KPIs for your factory.
I have discussed common KPIs measured by garment manufacturers. Following KPIs are covered under productivity level KPIs in my research.

1. Line efficiency
2. Standard minute value (SMV)
3. Cycle time, Available work time, changeover time, uptime, Value added time, lead time, Customer demand per month and Takt time
4. Man, to machine ratio
5. Right first time quality
6. Quality performance (DHU and Percentage defective)
7. Garment rejection rate
8. Lost time percentage
9. Machine utilization (Swing machine)

1. Line Efficiency:
Line efficiency indicates how efficient sewing lines are. This indicator is important because capacity planning of the factory and projected garment making cost are estimated based on average factory efficiency. Factory efficiency is nothing but the average efficiency of all lines.
Line efficiency is the ratio of total minutes produced by all lines and total minutes attended by direct labors in sewing floor

2. Standard minute value (SMV) :
Standard Time (also referred to as the "Standard Minute Value" or "SMV"), is the time required for a qualified worker working at "Standard Performance" to perform a given task. The SMV includes additional allowances for Rest and Relaxation, Machine Delay and anticipated Contingencies.

3. **Technical Measurement:**
- Cycle time: The time that elapses between one part coming off the process and the next part coming in
- Changeover time: the time to switch from producing one product type to another
- Available work time: The amount of work time available per shift in each process
- Uptime: The amount of time in which the machine is ruining
- Value added time: the time spent in transforming the product in a way that the customer willing to pay for.
- Lead time: The time for taken for one piece to travel through the entire value stream from start to finish.
- Customer demand in quantity per month
- Takt Time: The Takt time is time required to meet the customers demand. It calculated by dividing the net available time by the customer demand.

4. Man to Machine Ratio:
Man, to machine ratio is defined as number of total manpower per sewing machine. When it is factory's Man to Machine ratio (MMR), every employee of the factory is considered in calculation. For machines, only operational machines are considered

5. Right first time Quality:
Right first time (RFT) quality indicates to what extent garment components and garments are made correctly the first time without need for inspection, rework, or replacement. Improving Right First Time quality reduces cost of quality due to less rework, less inspection. Right first time quality can be measured at all check points –Like, sampling, cutting, sewing and finishing department.

6. Quality performance:
Defects per hundred per unit (DHU) is a measurement of quality performance in the sewing floor. In traditional garment production system (progressive bundle system) at the end of line, quality checker checks 100% garments. They also record defects and defectives pieces found to measure DHU of individual line. From this analysis factory, can assess rework and alteration level. DHU can be measured at all check points.

7. Garment rejection rate:
In stitching and finishing processes few defective garments are found those are not repairable even by changing part. Those garment pieces are considered as damaged or rejected pieces. Damaged garments could not be shipped to the buyer.

8. Lost time percentage:
This KPI is related to productive time lost in sewing floor, on which operator has no control. Lost time is also known as Non-Productive Time. Factory loses standard production time due to line setting, no feeding, machine breakdown, power cut are few examples of lost time. Lost time is one of the top most reasons for low factory efficiency. Factory analyses major lost times to control and improve machine and operator utilization.

9. Machine utilization (Swing machine):
Sewing machines are primary resources of a garment unit. In a factory machine capacity is kept based on average production load. Machine utilization is defined as the total time machines are used out of available machine time (expresses usually as a percentage).

Latif specific data sampling needs

Productivity-Participation questions:

Qualitative question to management:

Explain the initiatives taken by the management to involve employee to improve productivity.

Explain why you have this degree of employee involvement in productivity improvements (follow up to employee involvement/productivity).

What are the trainings the employees received for problem solving and to raise the issues to the supervisors or management in relation to productivity?

Explain if/how employees on the shop floor get training in solving problems related to the production (e.g. better ways of avoiding quality mistakes) (follow up to training question)

(interviewer should rate the training on the 1-5 scale)

If the company does housekeeping and/or 5S explain the role of workers in developing good housekeeping procedures/identifying limitations/mistakes in the current housekeeping/5S procedures (follow up to housekeeping/5S question)

(interviewer should rate the involvement of workers in housekeeping/5S on the 1-5 scale)

Explain the role of the worker in preventive maintenance including if they contribute to identifying mistakes/limitations/solutions ((follow up to preventive maintenance)

(Interviewer should rate the role of workers involvement on 1-5)

OHS-Participation questions

Explain the initiatives taken by the management to involve employee to improve OHS standards and practices.

Explain the degree to which the company is committed to involving the workers in solving OHS issues, and explain the communication that is done to the workers to make sure they know they can participate ((follow up to leadership commitment)

Explain the role of the workers/employees as a source of improvement of OHS in the official business policy (follow up to Business policy).

Explain how the workers aware about the buyer's compliance issues related to OHS.

Explain the extent to which there is dialog with workers on the shop floor on the relevance for them about buyer's compliance requirements (follow up on Relation with Buyer).

(interviewer rate the effort from 1-5)

Explain how workers are involved in monitoring OHS performance (follow up to Objectives, targets and performance measurement).

How they get training to improve their skills to involve in monitoring OHS performance?

(interviewer rate the effort from 1-5)

Explain if/how workers get training in fixing OHS issues (following up on training)

(interviewer rate the effort from 1-5)

Explain the role of workers on the shop floor in respect to OHS structure and accountability (follow up question to OHS structure ..)

(interviewer rate the effort from 1-5)

Explain the role of shop floor workers in accident investigations (follow up on Accident investigation)

(interviewer rate the effort from 1-5)

Explain the role of workers in respect to reporting unsafe behavior (follow up on Unsafe behavior)

(interviewer rate the effort from 1-5)

Explain the role of the safety committee/participatory committee in improving OHS and productivity issues

(interviewer rate the effort from 1-5).

How safety committee/participatory committee take part in decision making process?

Extra questions

How management encourages workers to involve in voice behavior in relation to improve working conditions and productivity?

Explain what is being done by the company to ensure that workers need to speaking up in front of managers

(interviewer rate the effort from 1-5)

How workers' voices are to be valued or rated by the management?

What management feels about the employee voice?

Explain what the company does to ensure that workers can provide suggestions for improvement anonymously

(interviewer rate the effort from 1-5)

Explain if the workers on the shop floor are viewed as source for finding synergies between OHS and productivity

How safety committee/participatory committee raise their concern to the management?

How workers' representatives in safety committee/participatory committee contribute in decision making process?

How the voice of workers' representatives in safety committee/participatory committee be evaluated?

Imranul specific data sampling needs

Data will be collected regarding three tentative paper ideas:

Idea 1: Buyer-supplier joint initiatives for supplier development: value creation within up stream global garment value chain

Questions to be asked regarding idea 1:

- Do you have any sort of collaborative development initiative with your buyers? if so, what are that initiatives? (e.g., joint R&D initiatives, joint product development, joint design development, joint strategy development, joint management system development, joint compliance initiatives, joint quality improvement initiatives, joint waste management, joint initiative for occupational health and safety (OHS) condition improvement, joint training initiatives for supplier firm's capability improvement, joint awareness programs, joint evaluation tools development, joint sustainability initiatives, any joint policy development, or any other joint initiatives)

- What motivates you to work for jointly with your buyers? What kind of value your buyers created for you? What kind of support you receive to develop your operational and compliance performance?
- How the joint development process helps supplier firms to upgrade (in terms of high value added production, manufacturing process improvement, diversification of products and production technology, catch-up higher value chain, higher export volume & export frequency, improvement of OHS condition, maintaining long-term relation,etc.)?
- Could you please specify any sort of co-development initiative that you have taken with the supplier firm particularly focusing on occupational health and safety (OHS)? If so, what is it, and how are you doing that?
- Do you think that cultural and institutional condition (regulative - government laws, enforcement mechanism, politicization and complexity in labor unions, normative, mental setting or psyche of the people, etc.) of Bangladesh negatively/positively affect the success and sustainability of the co-development initiative? If so- i.e. negative, how do you overcome the cultural differences and institutional weakness in the work process, and why do you think they are difficult to handle?

Idea 2: Tensions between buyers and suppliers and its impact on OHS conditions in supplier companies

How suppliers deal, and what is its consequence on OHS?

Questions to be asked regarding idea 2:

- How buyers evaluate your performance?
- What evaluation techniques they used for evaluating your social and business performance?
- What kinds of audits and how many audits you need to do in every year?
- What kind of certificates you have and why need to get certificates?
- What is the importance of certificates to buyers?
- How do you deal with buyers' expectations?
- What do you do when buyers create pressure to reduce cost?
- Why buyers create pressure to reduce cost?
- How do you reduce cost? Please give some specific example.
- Do you communicate buyers' expectations with workers?
- How workers are affected by reducing cost?
- Do you think that your relationship with buyers affect this cost reducing pressure? If yes, how?

- What kind of code of conduct you need to follow? Why you need to follow that?
- Do you get any benefit from buyers for following code of conduct?
- Who prescribe code of conduct and what kind of code of conduct buyers prescribe?
- How do you comply with buyers' code of conduct requirements?
- What buyers do if you fail to comply fully/partially?
- Do you think that your relationship with buyers affect code of conduct requirement?
- How tensions between buyers and suppliers can be benefitted?
- How both buyers and suppliers would be benefitted by reducing tensions?
- What is the role of NGOs, civil society, government, and other stakeholders in reducing ten-sions between buyers and suppliers?

Idea 3: Buyer induced standardization by lean tools and its influence on quality, productivity and OHS in supplier companies

Questions to be asked regarding idea 3:

- What 'determines' if/when buyer induced standardization requirements to suppliers results in positive direct effects on quality and indirect positive effects on productivity and OHS?
- How does the degree of trust between buyer and supplier impact the likelihood of a suc-cess-ful supplier development when buyers pursue a standardization strategy?
- What constitute the main internal supplier barriers in respect to successful upgrading (im-proved quality, OHS and productivity) by applying buyer developed standardization tools?
- What determines if supplier development by means of standardization results in no effects, positive direct effects or combined effects between quality and OHS/productivity?
- What does the buyer need to do differently to make the standardization efficient for suppli-ers?
- How does standardization can be sustainable and useful among the suppliers?

Interview guide for workers' voice

Qualitative question to management:

- Explain the initiatives taken by the management to involve employee to improve productivity.
- Explain why you have this degree of employee involvement in productivity improvements (follow up to employee involvement/productivity).
- What are the trainings the employees received for problem solving and to raise the issues to the supervisors or management in relation to productivity?

- Explain if/how employees on the shop floor get training in solving problems related to the production (e.g. better ways of avoiding quality mistakes) (follow up to training question)

(interviewer should rate the training on the 1-5 scale)

- If the company does housekeeping and/or 5S explain the role of workers in developing good housekeeping procedures/identifying limitations/mistakes in the current housekeeping/5S procedures (follow up to housekeeping/5S question)

(interviewer should rate the involvement of workers in housekeeping/5S on the 1-5 scale)

- Explain the role of the worker in preventive maintenance including if they contribute to identifying mistakes/limitations/solutions ((follow up to preventive maintenance)

(Interviewer should rate the role of workers involvement on 1-5)

OHS-Participation questions

- Explain the initiatives taken by the management to involve employee to improve OHS standards and practices.
- Explain the degree to which the company is committed to involving the workers in solving OHS issues, and explain the communication that is done to the workers to make sure they know they can participate ((follow up to leadership commitment)
- Explain the role of the workers/employees as a source of improvement of OHS in the official business policy (follow up to Business policy).
- Explain how the workers aware about the buyer's compliance issues related to OHS.
- Explain the extent to which there is dialog with workers on the shop floor on the relevance for them about buyer's compliance requirements (follow up on Relation with Buyer).

(interviewer rate the effort from 1-5)

- Explain how workers are involved in monitoring OHS performance (follow up to Objectives, targets and performance measurement).
- How they get training to improve their skills to involve in monitoring OHS performance?

(interviewer rate the effort from 1-5)

- Explain if/how workers get training in fixing OHS issues (following up on training)

(interviewer rate the effort from 1-5)

- Explain the role of workers on the shop floor in respect to OHS structure and accountability (follow up question to OHS structure ..)

(interviewer rate the effort from 1-5)

- Explain the role of shop floor workers in accident investigations (follow up on Accident investigation)

(interviewer rate the effort from 1-5)

- Explain the role of workers in respect to reporting unsafe behavior (follow up on Unsafe behavior)

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- Explain the role of the safety committee/participatory committee in improving OHS and productivity issues

(interviewer rate the effort from 1-5).

- How safety committee/participatory committee take part in decision making process

Extra questions

- How management encourages workers to involve in voice behavior in relation to improve working conditions and productivity?
- Explain what is being done by the company to ensure that workers need to speaking up in front of managers

(interviewer rate the effort from 1-5)

- How workers' voices are to be valued or rated by the management?
- What management feels about the employee voice?
- Explain what the company does to ensure that workers can provide suggestions for improvement anonymously

(interviewer rate the effort from 1-5)

- Explain if the workers on the shop floor are viewed as source for finding synergies between OHS and productivity
- How safety committee/participatory committee raise their concern to the management?
- How workers' representatives in safety committee/participatory committee contribute in decision making process?
- How the voice of workers' representatives in safety committee/participatory committee be evaluated?