UNIVERSITA' DEGLI STUDI DEL PIEMONTE ORIENTALE
DIPARTIMENTO DI GIURISPRUDENZA E SCIENZE POLITICHE, ECONOMICHE E SOCIALI

CORSO DI LAUREA IN EPPAC

TESI DI LAUREA

WORLD CLASS MANUFACTURING: OCCUPATIONAL HEALTH AND SAFETY

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ANNO ACCADEMICO 2014/2015

Abstract

The manufacturing world has faced many changes throughout the years and as a result the manufacturing industry is constantly evolving in order to stay ahead of competition. In the attempt to continuously improve management processes and production systems, many new manufacturing approaches emerged. World class manufacturing (WCM) represents one of the answers to these needs. The thesis describes principles and concepts of this new production management systems. The extent to which WCM is adopted in Fiat Chrysler Automobiles (FCA) company is examined. Focusing on FCA Italian plants (N = 4714), employees' perceptions on health and safety are investigated taking into account the main work organization practices introduced by WCM. Multinomial logistic regression analysis shows that there exist a positive relationship between the level of WCM implementation and the perceived level of occupational health and safety. The analysis also suggests that gender and age affect differently the perception of health and safety and the role of WCM in its improvement.

Acknowledgements

I am grateful to FIM-CISL trade union in the person of Alberto Cipriani for the permission to use the survey data, for the useful discussions, and for supporting me in direct confront with management involved in WCM implementation. In particular, I thank the Head of WCM Luciano Massone, the Head of Ergonomics eng. Stefania Spada, and the responsible of Health, Safety and Environment Simone Cencetti, who gave generously of their time, and who willingly shared their experiences. I also wish to thank Pomigliano and Maserati Grugliasco plants for their outstanding visits. Finally, I am grateful to all the workers I met for their preocious interviews.

Index

1. WORLD CLASS MANUFACTURING

1.1 World class manufacturing: definition and evolution

1.1.1 Introduction

The manufacturing world has faced many changes throughout the years and as a result the manufacturing industry is constantly evolving in order to stay ahead of competition. The rapid succession of changes shows the need for continuous improvement of management processes and production systems.

The goal of mass production was to create products with technological and commercial characteristics such that they could be manufactured and sold in huge quantities. Ford production system was characterized by high immobility and a series of structural constraints. The productivity optimization occurred by neglecting both customers and suppliers.

During the decades many aspects changed and this approach became obsolete and counterproductive. The technical limits of fordist assembly line techniques appeared, and the need for a more flexible and efficient production system emerged.

An inevitable transition from Fordism to post-Fordism, impelled by the competitive pressures, has therefore forced organizations to rethink their old forms of production and adopt new approaches to remain competitive.

Today's market has become more demanding in terms of quality, prices, and level of customer service. Enterprises need to adopt a modern production system customer oriented to face a context in which the number of competitors has greatly increased.

Increasing resource efficiency is an important issue for manufacturing companies to remain competitive. In addition to making the company profitable, increased efficiency can unlock large potential for innovation and growth in manufacturing industry.

Time has become a critical competitive factor. It is the benefits achieved through time reduction, in the form of greater cash flow, less inventory, quicker customer response and greater profits, that make time-based competition worthwhile (Handfield, 1995). Moreover, time-based competition does not just refer to manufacturing but to the entire product/value supply chain, which includes product development, order processing, supplier delivery, pre-production, manufacturing, final assembly and distribution. Thus, in the manufacturing environment, time-based competition becomes the highest priority to gain responsiveness and flexibility (Meyer, 1990).

The fast pace of change makes flexibility another determinant factor. Manufacturers must be able to rapidly change and innovate in order to deal with new determinants of competitiveness. Organizations must be able to keep pace with recent changes in an uncertain environment, identify customer expectations and immediately respond to any customer request. They are also demanded to seek for continuous innovation in their activities and production systems.

Innovation needed by manufacturing companies are primarily of three types (Pero, 2012):

- Market innovation (to expand markets and sell goods of high range)
- Product innovation (to move to products with higher technological and/or design content)
- Process/Organizational innovation (to gain in cost, productivity, flexibility and quality)

In the attempt to achieve innovation and competitive advantage in the market place context, many new manufacturing approaches emerged. Their aim is to continuously reduce cost and constantly improve processes.

Efficiency depends largely on the organization level of production systems and the range of application of modern production management tools. The use of these tools allows firms to improve the quality of manufactured products, reduce production costs, eliminate unnecessary waste, improve the control of the implemented processes, produce continuous improvement.

World class manufacturing (WCM) represents a set of work organization principles, managerial and manufacturing techniques, processes and systems, which combined together address an enterprise's needs in the more and more competitive and globalized business environment.

Some of the benefits of integrating WCM include increased competitiveness, development and improved technology and innovation, increased flexibility, increased communication between management and production employees, and an increase in work quality and workforce.

1.1.2 Evolution towards world class manufacturing

Until the 1970s, logistics were organized around the principle of mass production. These were as follows:

- Low cost had to be achieved through high volume production.
- Firms were organized in specialized department according to the type of working, in which there were many machines of the same type. Machinery was designed to produce large quantities of the same piece and machine changeovers had to be minimized. Large inventories of incoming materials, work-in-progress and finished products were held in case anything had interrupted the production flow.
- Quality inspection procedures were placed at the end of the production line. Defective products could be identified only at the end of the process and they were reworked before delivery.
- Work organization was designed to support this system with a net separation of labor between "who does" and "who manages". There were unskilled workers, easy to train and often paid on a piece-work basis in order to maximize production, and highly skilled workers concentrated on management, quality, design, marketing and control.

Such a kind of production system involved many criticalities. Workers specialized for single processings, who always worked on the same machine or station were subjected to repetitiveness and deskilling. Final quality control caused many wastes and a low quality of final products, as defective products were reworked and sold. These totally rigid mass production principles were fine insofar as markets were stable and relatively undemanding. Supply shortages meant that anything produced at a reasonable price and quality was quickly sold.

In Europe, North America and Japan, these market conditions began to change in the 1970s. Customers wanted increasing variety and quality, so that final markets became more heterogeneous and changeable. As the world became a much smaller place than before, manufacturers in almost every industry find themselves competing with companies from every corner of the earth. This situation led producers to adopt new organizational principles, which are in sharp contrast to the mass production pattern.

- Logistics are designed in order to ensure flexibility. This means producing in small lot to satisfy varied and volatile markets.
- Inventories are organized on a JIT basis and the displacement of material is minimized. Plants are organized in lines or islands with different machines that run work in close sequence. This allows production to flow through the plant as single units rather than in large lot. Production of components and final assembly are synchronized. Attention is paid to the reduction of tooling times and to the design of more flexible machines to ensure a rapid changeover between models.
- Quality control is ensured at each stage of the production process, so that no defect is allowed to pass through the plant.
- Work organization becomes much more flexible and oriented to learning and continuous improvement. Separation between "skilled" and "unskilled" workers becomes less pronounced. A key objective is to create multi-skilled worker (able to work in different stations) involving all the labor force rather than just the "skilled" engineers and managers.

Different names have been coined to represent the features of the new production philosophy, such as HPWO (High Performance Work Organization), HPWS (High Performance Work System), HPWP (High Performance Work Practices), Toyota Production System, Lean Production, World class manufacturing (WCM). Since they tend to attract attention on different elements, they have been considered as having different values. Nevertheless, they bring back mostly to the same idea. WCM is considered the internationalized and institutionalized point of reference of this philosophy. It delineates a set of organizational and production elements that characterize firms competing in the globalized market and embodies the concept of a dynamic system in continuous improvement.

Since the fifties, Toyota Motors Company in Japan was the pioneers of the new production philosophy, that was simply called Toyota Production System and only later has been known as Lean Production. Taiichi Ohno, a foreman who became a vice-president at Toyota, and Shigeo Shingo, a Japanese industrial engineering consultant, were the two major responsible for the development of such a system. Ohno's definition of the Toyota Production System is: "All we are doing is looking at the time line from the moment the customer gives us an order to the point when we collect the cash. And we are reducing that time line by removing the non-value-added wastes". (Japan Management Association, 1986). The core idea of the Toyota Production System is to continuously shorten the order fulfillment process and the product development process through the elimination of waste. As stated by Shingo the "method of reducing production delays is the foundation of the Toyota Production System". Shortening the entire process the manufacturer can deliver products on time without carrying large inventories and also receive feedback from the market more rapidly. This requires more accurate forecast in order to better align production to demand. These effects bring out the goal of the new production system: to bring manufacturing closer to the market by eliminating waste. The basic idea in the Toyota Production System is the elimination of wastes and inventories through small lot production, reduced set-up times, semiautonomous machines, continuous improvement, co-operation with suppliers, and other techniques (Monden 1983, Ohno 1988, Shingo 1984, Shingo 1988).

According to Shingo any operation which does not add value is wasteful. He identified seven kinds of waste, among which over-production is considered the worst because it contains all the other kinds. Each component of the production must be produced in the kind, quantities and at the time needed. The application of this concept leads to the elimination of unnecessary intermediate and finished product inventories (Monden 1983). Together with cost reduction - the most important goal-, other sub-goals have to be achieved. They include: a) quantity control which allows adaptations to demand fluctuations in terms of quantity and variety; b) quality assurance which assures only good units to subsequent processes; c) respect for humanity which includes human resources development. The end result is a simplified model of work flow, which ensures the alignment between the output from the supply chain and the demands placed on it by the market.

This was the background that leads to the development of World class manufacturing. The ideas began to spread in Europe and America since 1975, especially in the automobile industry. Nowadays, it is implemented, at least partially, by major manufacturing companies in Europe and America. It has also spread to new sectors, such as customized production, services, administration and product development.

The practical implementation of WCM has spread without any theoretical base. Factory visits, case descriptions and consultants have been the principal means of knowledge transfer. Since the eighties many authors have formulated theoretical definitions and sets of implementation principles. In spite of this, they widely differ and there is as yet no unified, coherent, and consistent theory. The techniques have been refined and improved by industrial engineers, new approaches and tools have been established; but the approach has not been systematized into a scientific and wide pattern. In particular, new approaches to manufacturing are based on a pragmatic philosophy distilled from the concrete and continuously evolving experience of worldwide companies.

1.1.3 What is World Class Manufacturing?

The term *World class manufacturing* was first used by Hayes and Wheelwright (1984) to describe a set of manufacturing practices whose use would lead to superior performance. The authors described the capabilities which had been developed by Japanese and German companies in order to compete in export markets. America, it was argued, exported less than 10 per cent of its capital goods, while a comparable figure for Japan and Germany was over 50 per cent. The term WCM refers to the outstanding performance in the industry the manufacturing belongs to. This concept was originally based on Asian experimentation of higher quality levels and the simplification of process. In their analysis based on the comparison between Japan and Germany firms and US firms, they found six critical practices leading organizations to the achievement of a global competitive advantage: workforce skill and capabilities, management technical competence, competing through quality, workforce participation, rebuilding manufacturing engineering, incremental improvement approaches.

Since then, the concept has been expanded and refined by many authors, who have reinforced some of the original ideas, added some new practices and ignored others. However, its aim is to achieve global competitiveness by adhering to the following principles: cost reduction, improved security, development of applied processes, increased productivity, no waste, no stock, no failure, no defect, customer satisfaction with products and services, value-added activities, involvement and development of employees. These goals are linked together within the framework of continuous improvement. WCM attaches importance to the employees' role within the system. Development and appreciation of employees, as well as the use of team work and the acquisition of related skills constitute key principles of WCM.

Schönberger used the term in his second major book "World Class Manufacturing" (1986). He states that WCM "captures the breadth and essence of the fundamental changes taking place in industrial enterprises". He emphasized the manufacturing companies were looking for robustness capabilities in order to be stronger, faster and to reach higher standards. According to him the goal of WCM is "continual and rapid improvement" in quality, cost, lead time, customer service and flexibility. Continuous improvement in all these fields will lead to world class status. He collected several cases and experiences of US firms that had followed the continuous improvement path, trying to build a systematic conception of the various techniques and methodologies examined. He provided a list of sixteen principles of WCM, most of whom correspond to Hayes and Wheelwright's practices. He also builds his description of WCM on new manufacturing practices such as quality management, Just In Time (JIT), and Total Productive Maintenance (TPM). Producing more than what can be sold is costly and wasteful. So, to reduce cost and waste a WCM precept involves to produce some of every type every day and in the quantities sold that day (JIT).He advocates for cellular manufacturing to gain improvement in factors such as quality, cost, lead time, flexibility, delays, inventory performance, scrap, equipment up-time, worker skills.

According to Maskell (1991), WCM is a very wide term which generally focus on product quality, JIT production methods, a new workforce management and a flexible approach to customer requirements. The new approach to product quality is based on the principle: the smaller the lot size, the better. It places more emphasis on the resolution of the problems that cause poor quality in order to achieve a zero defect target. WCM approach is directed to identify the roots of quality problems and systematically resolve them, rather than merely reveal the problems. Moreover, quality control responsibility is placed on floor with the production operators. The goal of JIT manufacturing is to eliminate the inventory that is not immediately necessary for production. It is based on the principle: the smaller the lot size, the better. This purpose is achieved by: a) reduction in production set-up times; b) reduction of materials movement through a change in the shop-floor layout; c) synchronizing the manufacturing process so that each component is available just when it is needed; d) creating mutually beneficial relationships with suppliers. A third set of precepts is called Total Productive Maintenance (TPM), a regime of comprehensive maintenance activity, carried out largely by the operator of the equipment (not by maintenance specialists) in order to ensure zero downtimes of equipment. The workforce management approach is the most complicated to implement since it requires a radical change in management style and philosophy. It includes practices such as: a) transfer of responsibility giving operators greater control on their daily work; b) education and cross-training provide employees with a broader range of tasks and skills; c) problem-solving and quality circles create a team work environment which enable workers to become innovative and resourceful problem-solvers. (Maskell, 1991). As for flexibility, there are two aspects of flexibility that are important to reach a significant competitive advantage: production flexibility and design flexibility. The former is achieved when the company can offer short lead times, when the product mix within the plant can be changed significantly from day to day, and when workers are cross-trained to manufacture a wider range of products. The latter is related to the company's ability to introduce new products and modify the currents. A company must be able to understand the current and future needs of its customers, to develop innovative products and to get those products to the market place quickly. (Maskell, 1991).

Oliver et al. (1994) from a comparison made between nine Japanese and nine UK automotive components companies, observed that "to qualify as world class, a plant has to demonstrate outstanding performance on measures of both productivity and quality".

According to Gunn (1987), WCM bases itself on three pillars: Computer Integrated Manufacturing (CIM), Total Quality Control (TQC) and Just In Time (JIT) production methods. By addressing these three fundamental approaches at once it is possible to gain competitive advantage in modern manufacturing. Gunn propounds a number of criteria for evaluating a company's world class status, such as inventory turnover, quality defects and lead times.

Womack et al. (1990) gave a mean for quantifying World class manufacturing through their definition of Lean production. It "uses less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than half the inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products". The authors stated that the principles of lean production "can be applied equally in every industry across the globe" and that "lean production will supplant both mass production and the remaining outposts of craft production in all areas of industrial endeavor to become the standard global production system of the 21st century".

Generally speaking, being a world class manufacturer means to be able to compete in a chosen market with the best anywhere in the world - regardless of size, country of origin or resources. It means matching or exceeding any competitor on quality, lead time, flexibility, cost/price, customer service and innovation (Infor, 2007).

Nowadays customers making a purchase are not only interested in the product but also, to a large extent, in extra services provided under the purchase contract. Kinni (1996) characterizes World class manufacturing by three core strategies - customer focus, quality and agility (i.e. the ability to quickly, efficiently and effectively respond to change) - and six supporting competencies - employee involvement, supply management, technology, product development, environmental responsibility, employee safety, and corporate citizenship. In order to successfully meet these requirements a WCM approach runs criteria like the followings: deliver on the shortest lead time, always on time, offer a product with better features and cheaper than those offered by the competition, made perfectly, to any design the customer wants. (Colin, 1992).

The principles of WCM are usually implemented involving the following philosophies, tools, and techniques:

- Just-in-time (JIT)/Make-to-order
- Small lot sizes
- Kanban system
- Families of parts
- Doing it right the first time
- Cellular manufacturing

• Poka Yoke

• 5 S

• Six Sigma

• Total Quality Management (TQM)

• Total preventive Maintenance (TPM)

• Quick changeover/Single Minute Exchange of Dies (SMED)

• Zero Defects

• Zero Quality Control

• High employee involvement

• Cross functional teams

• Multi-skilled employees

•Visual management

• Statistical Process Control (SPC)

As shown by the background, taken independently none of WCM principles is new. They have been known for a long time and most of WCM concepts can be traced back to Lean production. Each of these tools is important in itself, but only their implementation as a whole can lead to world class status. The implementation also requires a continuous research to improve the overall organizational effectiveness. To achieve world class status, companies must change procedures and concepts, which in turn leads to transform relations among suppliers, purchasers, producers and customers.

The novelty of WCM is, therefore, to combine the best and simplest practices into an integrated approach. WCM represent a simple and systematic model with a global network. It encompasses Lean production, placing itself as an organic, global approach. Manufacturing excellence, which is the aim of these approaches, refers to an improvement in its broadest context.

1.2 The basic requirements for WCM

Productive and management tools that make up WCM are manifold. There have been established a number of principles to design, control and improve flow processes. Different scholars and practitioners who have dealt with it have formulated different sets of principles for implementation. In the following paragraphs only some of the main ideas, that are the basis of the WCM, will be taken into account. The treatment of these elements does not want to be exhaustive, but only to give a general idea of some fundamental aspects of the WCM which are common to different approaches and implementations.

1.2.1 Process orientation

World class manufacturing is based on a new concept of production model. Shigeo Shingo is considered the pioneer of this new concept called *process orientation*, later developed by the business process re-engineering (BPR).

Production can be defined as a flow of material and information from raw material to the final product. In the flow, material is processed, inspected, transported and stored. The new concept is based on a dual view of production. All production activities are composed of a "network of processes and operations" (Shingo, 1989).Processing activities are alterations of shape or substance, assembly and disassembly through which material is transformed into a product; they represents the conversion aspect of production. Inspecting, transporting and storing are operations performed on the material by machines and workers; they constitute the flow aspect of production.

Flow processes can be characterized by time, cost and value. Value refers to the fulfillment of customer requirements. In most cases, only processing activities are value-adding activities. (Koskela, 1992). A process is the way by which value is added to a product that a customer is waiting for; a flow implies an operation performed on this product by a worker or a machine. The overall production efficiency is ascribable to both the efficiency of the conversion activities performed, and the amount and efficiency of the flow activities. While all activities involve cost and consume time, only conversion activities add value to the material being transformed to a product.

Improvement in the production process can arise only from their separate analysis. The improvement of flow activities needs primarily to be focused on their reduction or elimination, whilst conversion activities have to be made more efficient.

1.2.2 Value-adding activities

In general, a value-adding activity is anything that finds some usefulness for the final customer. A non value-adding activity (also called waste) is anything that takes time, resources or space but does not add value. (Koskela, 1992). Reducing the share of non value-adding activities is a fundamental guideline in the achievement of manufacturing excellence. In value-added manufacturing one must "purge anything that does not add value to the product or service, whether material, equipment, space, time, energy, systems, or human activity of any sort", Hall (1987).

The value-added manufacturing framework is based on several principles:

- Take a broad view of operation
- Make problems visible to everyone
- Keep it simple
- Improve operations before spending on new plant and equipment
- Flexibility

To reduce non value-adding activities a needful task is to identify the most significant waste activities. Shingo (1981) gives a summary of the seven wastes, where waste is anything that does not add value to the product or service. These seven wastes and their methods of elimination are collected in Table 1.

The volume of non value-adding activities seems to dominate most processes. Christian et al. (1995) found that workers spent only 46% of working time on the value-adding activities. Other studies report worse results. According to Ciampa (1991) usually only 3 to 20 % of steps add value, and their share of the total cycle time is negligible, from 0.5 to 5 % (Stalk & Hout, 1990).

Table 1: Shingo's seven wastes.

Waste Type	Elimination Method
Waste of overproduction	Reducing set-up time, synchronizing quantities and timing between processes, etc.
Waste of waiting	Synchronizing workflow as much as possible, balancing uneven loads, etc.
Waste of transportation	Redesigning layouts to make transport and handling unnecessary.
Waste of processing itself	Need assessment of product and process.
Waste of stocks	Reduce set-up times, and lead times by synchronizing workflows
Waste of motion	Study motion for economy and consistency.
Waste of making defective parts	Prevent defects to eliminate inspection.

Conventionally, the production process has been regarded as a conversion of an input to an output. Non value-adding activities have been considered as existing in the nature of production and most of activities have been considered as conversion activities. Therefore, little attention has been placed on the possibility to reduce the amount of non value-adding activities. However, it is possible to directly attack the most visible waste just by flowcharting the process, then pinpointing and measuring non value-adding activities. With WCM activities such as transportation of materials or work-in-process, problem related to defects, errors or accident are no longer considered in the nature of production. Such activities are eliminated at the root or highly reduced. For example, sideline carts drastically reduce the waste of motion that workers used to do for finding and then moving materials from the warehouse to the line.

1.2.3 False tradeoffs and SMED

Hayes and Wheelwright (1984) defined competitive priorities as the ways in which firms choose to compete in the marketplace. They explicitly warn against the pursuit of multiple competitive priorities, stating:"It is difficult - if not impossible, and potentially dangerous, for a company to try to compete by offering superior performance along all of these dimensions simultaneously, since it will probably end up second best on each dimension to some other company that devotes more of its resources to developing that competitive advantage." A number of other authors have supported the idea according to which the lack of success would lie in the pursuing of multiple competitive priorities simultaneously: Porter (1981, 1985), Kotha and Orne (1989), Hill (1989), Anderson et al. (1989), Hayes and Pisano (1994), Miller and Roth (1994), Clark (1996).

The tradeoffs theory has been outdated by WCM. A fundamental change in the WCM philosophy is the idea to eschew the conventional optimization approach to problem solving. The new approach tries to overcome the tradeoff by reconciling those which are seemingly conflicting objectives. Competitive priorities can reinforce each other, rather than functioning as tradeoffs (Ferdows and De Meyer, 1991). The strategic importance of WCM tools lies in their combination which allows to hold together different goals. Rather than viewing performance as the result of trade-offs - between cost and quality, for example - the WCM perspective states that firms can pursue several outcomes simultaneously (Ferdows and De Meyer 1991). A world class manufacturer needs no longer to choose which types of performance to focus on; rather he needs to achieve high level performance across the board (Schönberger, 1986).This perspective is supported by authors such as Womack et al. (1990), Vickery et al. (1993), Ward et al. (1994), D'Aveni (1994), Kotha and Vadlamani (1995). Shingo (1989) was a major force behind this approach. He approached the tradeoffs problem through the dialectic reasoning. In a perspective of thesis and antithesis, the conflict (tradeoff) can be resolved and overcome. The opposition vanishes once a higher level synthesis is reached.

An example of application of the dialectic process is the SMED system (Single Minute Exchange of Die). According to the theory of the Economic Order Quantity (EOQ) smaller production lot size implies lower level of investment in inventory and a larger number of set-ups. Since the more the set-ups, the greater the time required, costs of lost production would be incurred. On the contrary, larger lot sizes imply larger inventories and hence larger inventory carrying costs. The objective was therefore to choose the optimal lot size in order to minimize total inventory carrying cost and set-up costs.

SMED was conceptually developed by Shingo, whose system helped to reduce the set-up time on a large press at Toyota's main plant from four hours to one-and-a half hours, and subsequently to three minutes. He realized that only a lack of focus on eliminating all waste of time in set-up activities lead to set-up costs and any set-up could be performed in less than 10 minutes. The term "single minute" in SMED refers to a single-digit time span in minutes (less than 10 minutes) and does not imply a one minute set-up. Shingo noticed that there were two types of set-up operations:

- Internal set-up-operations (such as mounting or removing dies on a press) that could be performed only after the machine had been stopped.
- External set-up-operations (such as transporting press dies to and from storage, bringing a jig or a fixture to the machine) that could be completed when the machine is running.

Once internal and external set-up operations are identified, no distinction has to be made between them. Delays in internal set-up must be targeted for elimination and internal set-up operations must be converted to external to the extent possible. Additional improvements are made through eliminating adjustments and streamlining clamping methods, leading to one-touch exchange of dies.

Shingo and others (Shingo, 1989; Hall, 1983; Mondenl, 1983) have discussed techniques for set-up time reduction in detail. Production sites with long set-up times are characterized by low flexibility and high level of stocks. The use of SMED leads to benefit such as reduction in lead time, higher productivity, reduction in working capital, possibility of using Kanban systems, less disturbance. It is a systematic approach that is used for exchange of dies, but also for cleaning and regular maintenance. Decreasing the set-up times the extra capacity could be used either to increase productivity or to decrease the lot sizes.

1.2.4 Just in Time

JIT is a management philosophy which was developed by Taiichi Ohno in Japan and has been applied in practice since the early 1970s. It originally referred to a means of meeting customer demand exactly in time, quality and quantity, whether the customer is the final purchaser of the product or another process further along the production line. In a broader meaning, it has come to mean producing with minimum waste. Its aim is to eliminate manufacturing wastes by producing only "the right material, at the right time, at the right place and in the exact amount". Waste is intended in its most general meaning and includes time, resources and material. JIT philosophy regards inventory as a waste, a cost. This is based on the fact that wastes result from any activity that adds cost without adding value to the product, such as transferring inventories from one place to another or storing them. Whereby, JIT system works in order to minimize the amount of non-value-adding operations and the inventory levels at the various stations of the production line. It implies a constant improvement of the processes in such a way that they require less and less inventory. A good coordination between stations is necessary: the preceding station produces only the exactly volume that the next station needs and pull in. Inventory is moved within the line according to a *pull* system. The requirement of the next station is what modulates the production of a particular station. This requires an evenly matched and balanced capacity of the various work stations that the materials pass through. Through JIT, production flow and floor are defined in order to make the flow of materials through the line smooth and unhindered. This results in a reduction of material waiting time, shorter throughput times, better on-time lead time, higher equipment utilization, lesser space requirement, lower costs, greater profits.

In a JIT system, supplier relationships acquire an extraordinary importance. Supply needs to be synchronized with production demand in order to avoid problems and to always ensure the optimal amount of inventory.

When properly adapted to the organization, JIT philosophy strengthens the organization's competitiveness in the marketplace substantially by reducing wastes, simplifying the process, and improving product quality, efficiency of production and customer satisfaction.

A number of tools can be used to achieve JIT manufacturing. Some of them - reduction of non-value adding activities and set-up time - have been discussed previously. Others elements will be presented in the following sections. These include: Kanban system, Total Quality Management (TQM), Poka Yoke, Total Productive Maintenance (TPM), 5S system, multi-skilled workers and team work.

1.2.4.1 Kanban System

Kanban systems is often associated with JIT implementation. Ohno (1992) described it as an "operational tool that carries out the Just in Time production method."

It represents a simple tool to pull products and components through the process. The pull system was inspired by the functioning of American supermarkets. According to Ohno (1992) "A supermarket is where a customer can get: (1) what is needed, (2) at the time needed, (3) in the amount needed". Ohno adopted this operating model as a model for material flows on the shop floor. Applying the supermarket concept to the production line, the earlier process becomes a kind of store. The later process (customer) goes to the earlier process (supermarket) to get the needed parts at the time and in the quantity needed. Operators must ensure that customer can buy what he needs at any time. So, the earlier process immediately produces the quantity just taken (restocking the shelves).As in a supermarket, components and parts needed to manufacture a product ordered by the customer are gathered through a kitting process. Individual components are collected from areas specially crafted based on the mix of material organized for families and codes. They are then issued to the point of use.

Kanban is the Japanese name for *signal*. It is a card attached to the carrier or container used to match what needs to be produced in a work station and what needs to be delivered to the next. As mentioned before, a JIT system is basically a pull system in which what needs to be produced in a particular station depends on what the next station needs. The purpose of Kanban is therefore to register and signal how many component parts need to be produced. A Kanban card contains information about the lots and quantities involved, so that no component that cannot be processed in succeeding stations will be produced.

The use of Kanban system and supermarket model allows companies to get the following benefits:

- Prevention of assembly errors
- Synchronization of material flow
- Elimination of unnecessary movement
- Reduction of inventory
- Reduction of processing times

• Improvement of line side assembly

Table 2 sums up functions and rules governing the Kanban system as explained by Ohno(1992).

Table 2: Kanban system.

Functions of Kanban	Rules for Use
Provides pick-up or transport Information	Later process picks up the number of items indicated by the kanban at the earlier process
Provides production information and sequence indicated by the kanban	Earlier process produces items in the quantity
Prevents over production and excessive transport	No items are made or transported without a kanban
Serves as a work order attached to goods	Always attach a kanban to the goods
Prevents defectives by identifying the process making the defectives	Defective products are not sent on to the subsequent process. The result is 100 per cent defect-free goods
Reveals existing problems	Reduce the number of kanban to increase their sensitivity

According to Monden (1983) a Kanban system can be meaningful only if supported by the following management practices: smoothing of production, reduction of set-up time, cellular plant layout, standardization of jobs, improvement activities, and automation.

Kanban is not a great tool *per* se. The challenge lies in creating an organizational climate in which the Kanban serves as a useful information tool for the shop floor. If kanban is implemented in a conventional environment there will be a larger number of kanban to compensate for the waste built in the process. However, one of the objectives of WCM is to continuously reduce the number of Kanban in circulation.

1.2.5 Total Quality Management

Total Quality Management (TQM) is a structured system that look at gaining competitive edge by increasing customer satisfaction through continuous improvement. The quality of products, processes, and resources of an organization is managed in order to satisfy its internal and external customers. TQM also tries to manage the quality of inputs from suppliers. Quality is accomplished by systematic methods for problem identification and resolution, best practices achievement, and maintenance of good results (standardization).

In correspondence with the evolution of the concept of quality, different quality methodologies have been developed:

- Quality Control
- Total Quality Management
- Zero Defects

The starting point of the quality concept is the Quality Control. This discipline places its emphasis on control, such as written procedures, management to ensure compliance with those procedures, solid record-keeping, training and certification, and elements of organizational culture to promote these disciplines. (Olofsson, 2013). The quality concept then evolved from mere inspection of materials and products to TQM. Total refers to three extensions: (1) expanding quality control from production to all departments, (2) expanding quality control from workers to management, and (3) expanding the notion of quality to cover all operations in the company. (Shingo, 1988).

TQM may be considered as a collection of principles and tools that are being used effectively in quality management of manufacturing industries, maintenance organizations and service organizations. From results of different surveys conducted, it is estimated that more than one hundred TQM tools are being used so far. (http://world-class-manufacturing.com/). But they are differently described depending on the books.

It is important that everyone within an organization practice TQM in the structured manner set forth by management. Consequently, TQM methodology needs always to be structured and internally standardized. Nevertheless, there is no standard or rigid procedure for implementing TQM. Every company can chose the best manner for its organization.

Without going into TQM tools details, a set of the basic principles can be presented:

- TQM is customer-centric: quality goal must be based on customer requirements.
- Quality is perceived as the responsibility of the entire organization: every employee has a customer to delight and is responsible for quality.
- Processes, not the people, are the problem. Problems must be prevented.

- Quality must be measured so that it can be controlled.
- Quality improvements must be continuous. Since the customer's needs are continuously changing, TQM must necessarily implement systems to further improve processes, products, and services.

Zero defect is a quality-oriented program developed in Martin Marietta Corporation in the 1960s. It is based on the principle that preventing defects is better than inspecting and correcting them. This because defects cost money. The following paragraph explains how Poka Yoke concept can leads to achieve zero defects standard.

1.2.5.1 Zero defects through Poka Yoke

As defects belong to one of the seven categories of waste aforementioned, their elimination is important because it reduces costs while at the same time increases customer satisfaction. Defects contribute greatly to the cost of production because they lead to rework or scrap the manufactured product, in addition to warranty and inspection costs.

Poka Yoke is a quality management concept developed by Shingo which aims at achieving zero defects. Poka Yoke comes from two Japanese words - *yokeru* which means *to avoid*, and *poka* which means *inadvertent errors*.

The approach focuses on preventing process or product errors from occurring, in order to reduce the need for reworking of defective parts. The cardinal principle of this system is that no process should produce, accept or pass defective parts to the subsequent process. By carrying out inspection within the process, each stage in the manufacturing process checks for and prevents errors from passing to the next process. By continually applying such a control, that is more effective that the final one, the process will eventually be incapable of generating any failure.

Poka Yoke implementation is characterized by the usage of simple devices that prevent people from committing mistakes, even if they try to. Such devices are, for example, fixtures, jigs, gadgets, paper systems, warning devices. A good device needs to be simple to install and to be used from worker. It should not require continuous attention from the operator, since human errors usually derive from people who get distracted, tired or confused. Finally, it needs to provide feedback, correction, and especially prevention.

Poka Yoke devices usually stop the machines and alert the operators if something is about to go wrong. They can be classified in the following types.

- Contact method: a sensor determines the presence of a part in a process and if the part is missing or wrong, it prevents the process from continuing. The sensors could be physical sensors or energy sensors such infrared. They identify the product defects by testing the product's shape, size, color, or other physical attributes.
- Fixed-value method: physical and visual sensor determine whether a process is completed by the right number of components and steps. If the right number of steps or components have not been used, it indicates an error and the process is stopped.
- Motion-step method: a sensor determines whether the prescribed process steps and their sequence have been followed. If a step in the process has been missed, a signal is sent to the subsequent process to stop. This forces a correction of the problem before the process can continue.

As highlighted by these methods, Poka Yoke approach can significantly reduce the impact of quality concerns. The final product will be of high quality as the mistakes are corrected long before they can reach the final customer. Cost of rework and inspection at the point of dispatch are consequently reduced.

1.2.5.2 Six-Sigma

Six-Sigma is a methodology of quality management. The process is designed to measure, control and improve quality. It allows to manage more efficiently and effectively business processes, mastering criteria of cause and effect at the base of their operation. This provides the opportunity to identify, quantify and remove activities that do not bring benefits to profitability, and to define new standards of work.

The term Six-Sigma was coined in the 1980s at Motorola Corporation, where it was developed as a tool for supporting the improvement of production processes. It evolved through the contributions of other companies first in a program of total quality, and then in a managerial model wherewith to manage the entire business.

Six-Sigma approach aims at improving customer satisfaction by improving the *capability* of the process, that is the degree to which the output of the process meets the specifications provided. The name reflects the goal of reducing the statistically-determined defect rate to six sigma. In statistics *sigma* (Σ or σ) is the standard deviation from the mean, which is an indicator of how far the samples deviate from the average value. A defect is a value which is outside the accepted range. The number opportunities for a defect is calculated by multiplying the number of products by the number of metrics (length, weight, etc.) being measured. Then an $n\ \sigma$ process is determined by the percentage of defects in the output. $3\ \sigma$ was an earlier standard that permitted a 6.7% defect rate. A $6\ \sigma$ process has no more than 3.4 defects per million opportunities. (http://world-class-manufacturing.com/).

In short, Six-Sigma goal is to hold the number of defects extremely low. It expanded and strengthened previous quality approach by shifting its focus from final measurements of defects toward controlling the processes in order to minimize defects.

Six-Sigma program focuses on specific objectives, numerically measurable. It requires the involvement of all staff in the use of statistics, in the activities of measuring and data collection, analysis, and improvement actions.

1.2.6 Total Productive Maintenance

Total Productive Maintenance (TPM) refers to a management system that aims at achieving production efficiency and uninterrupted operations through a quick, proactive maintenance response to prevent equipment-specific problems. The intent is to create a production environment free from mechanical and technical breakdowns without the need to rely on mechanics or engineers.

Employees at every levels are involved in the effort to maximize production output by maintaining ideal operating conditions. In this way it is possible to minimize production losses from equipment repairs, assistance, set-ups, and so on.

The increasing complexity of machines due to modernization and automation enhanced the gap between operators and their machines. This led to a net separation between operators and maintainers. When a trouble occurred the operator stopped the work and called the technician to fix the problem. This traditional approach caused high maintenance expense due to the waste of work hours, production time, opportunity lost.

TPM provides operators with the necessary skills to deal with mechanical and equipment problems. They no longer limit themselves to call engineers and mechanics when a breakdown occurs. Since they are prepared and trained they can clean, lubricate, inspect, adjust, and perform some calibrations on their respective equipment.

The concept of TPM does not only address operators, but it extends up to top management. The manufacturing environment that results is an environment wherein everyone feels as his responsibility to keep the equipment running and productive. Zero breakdowns, zero defects, and maximum productivity become shared goals and everyone is involved in pursuing them.

The main goals of TPM can be summed up in the elimination of the following sources of wastes:

- Equipment downtimes with expensive repairs;
- Minor stoppages;
- Defects and Rework;
- Set-ups, conversions, and changeovers.

Thus, improving equipment productivity, TPM also improves operational efficiency, cycle time, personnel effectiveness, and customer satisfaction.

1.2.7 5S Implementation

The 5S process is a structured method to promote cleanliness, orderliness, and organization in the workplace. The program does not run out itself, it is a systematic approach. It aims at improving messy, disorganized, dirty and hazardous places, and then at standardizing the improvements. It leads to a new quality standard that results in the achievement of sustained improvements.

A better-organized place produces a safer, more efficient, and more productive environment. A cleaner and more ordered workplace reduces the risk of injuries, and can also results in fewer chronic health ailments in the long run. 5S lead to more optimized workflows thanks to the elimination of wastes of time related to the search of misplaced items or to the breakdowns of equipments. A cleaner environment also boosts the morale of the workers, since working in a such workplace is more enjoyable. As well, the common goal of maintaining 5S standard can increase the sense of responsibility as a teamwork. Therefore, each aspects of 5S implementation can results in short and long run benefits, each of which will results in higher productivity.

5S methodology was invented in Japan, and the name refers to five Japanese words that start with the letter *s*.

Seiri is the first step of the "5S" process. It means to *Sort* and it is about organization. It refers to the act of eliminating all materials from the workplace that are not needed for current production operations. Items left in the workplace need to be related to work and they must be kept in the minimum quantity. The basic tool for Seiri is a red tag. It is placed on all items that are not needed for operations or that are not in the proper quantity or location. The additional tool is the Sort List: a log to follow up every red tag. Once the item is tagged, it is then moved to a central holding area for subsequent recycling or reassignment. Sorting in a team activity that allows to free up valuable floor space and to eliminate such things as broken tools, scrap, obsolete spare parts.

Seiton means to *Set in order*. The principle is to create efficient and effective storage methods to keep things in the proper place. Items are labeled and arranged in an assigned place so that they can be accessed and retrieved rapidly. The correct place for every items must be chosen in relation to how frequently they are used. Frequently-used items must be kept handy, while rarely-used items must be stored where they can be easily found. All items should be located so that workers do not bend or stretch frequently. The simple identification of the items and the quick access to them make the work flow efficient and productive.

Seiso or *Shine* consists of thoroughly cleaning up the work area. Cleaning is a team activity that must be done daily in every area of the workplace. Important reasons are at the basis of this particular attention for cleaning. Working in a clean environment enables workers to notice maintenance issues in equipment such as leaks, breakdowns, misalignments, and to act before they lead to loss of production. Cleanliness also makes the workplace safer, easier, and more comfortable, as well as improves product quality.

Seiketsu is translated in *Standarize*. It consists of defining the standards of the bests practices of cleaning in the work area. The approach creates tasks and procedures whereby workers can measure and maintain Seiso. Some of the tools used in standardizing the procedures are: visual signals (e.g., color-coding, placards, display scoreboards), job cycle charts, and check lists.

Shitsuke denotes the commitment to *Sustain* the correct procedures and to practice all the steps as a way of life. It is a Japanese concept that includes self discipline, instilled discipline and self-motivation to improve. The importance of Shitsuke lies in the cultural change of behaviors that it produces. Without this change the achievements of the other steps would not last. For this reason Shitsuke requires continuous management support and communication. Once it becomes a common value within the organization, workers will naturally and constantly observe the good practices regarding cleanliness and orderliness. Typical tools for sustaining the 5S are performance reviews, pocket manuals, signs and posters, team and management check-in, department tours.

1.2.8 Kaizen

Kaizen is a Japanese word that stands for *continuous* (kai) *improvement* (zen). It is the principle that underlies the whole philosophy of WCM. All the principles presented above are embedded in the framework of continuous improvement. It was introduced by Taichi Ohno at Toyota Motors Company as a tool for Lean Manufacturing.

Kaizen is a management concept that aims at improving all the aspects of a company by making little, but constant and incremental improvements. The peculiar feature of Kaizen is not improvement in itself, but its never-ending process. Kaizen doesn't try to reach great and radical improvement once in a while. On the contrary, its main idea is to achieve everyday small improvements involving everybody within the organization.

According to Masaaki Imai (1986) it is "a means of continuing improvement in personal life, home life, social life, and working life. At the workplace, Kaizen means continuing improvement involving everyone - managers and workers alike. The business strategy involves everyone in an organization working together to make improvements without large capital investments."

A significant principle is that contributions to improvement may come from each employees. Improvement does not come only from the top (managers) or from outside (consultants). Workers at every level of the organization have the responsibility and the authority to make suggestions.

As human resources become a fundamental asset for the company's success, they must be given the necessary training and education in order to turn from executors in contributors of such a success. Kaizen needs to become a mindset which permeates the entire company, in order to have the entire workforce proactively engaged in improving processes.

In order to support Kaizen, management needs to establish a system of incentives and rewards which encourages workers to make suggestions. Management must also be able to promote cross-functional teams, that through a collaborative and systematic approach manage to analyze problems and generate solutions.

Kaizen should be applied to each area of the organization and in a variety of aspects including efficiency, safety, quality, employees and customers' satisfaction. Kaizen aims at improving efficiency by reducing wastes and producing more value in the process. Improvements must be based on statistical and quantitative studies of the performance of the process. Once changes have been standardized, there is always room for potential changes and new improvements. This is the core idea of Kaizen: everything can be improved even if it works well and has no problems. It sets replicable standards and then continually improve those standards. Improvement activity must be carried out continuously.

1.2.9 Human Resources Dimension: the importance of Employees Involvement

In WCM people are considered a fundamental asset in the continuous improvement of a company's competitive advantage. The principal impediments to the implementation of WCM are often considered technical. However, managing people is the most critical issue in achieving WCM status. People's lack of knowledge, resistance to change, or lack of ability to quickly absorb new philosophies, ideas, and practices constitute the main obstacle for a good WCM implementation. Employees education and involvement are, therefore, building blocks for organizational success. To equal technology and management system, the best advantage comes from the development of the workforce. Moreover, many companies have recognized that there are limits to the extent to which work can be automated. So greater importance has been put on workers and the development of their skill, motivation, ability to solve problems and capacity to learn. Enhancing competitiveness by improving operating efficiencies, cutting costs, eliminating waste, downsized, and outsourced is not sufficient. A WCM company also needs to manage people differently.

In a WCM organization the workers' ability to think and suggest improvements is recognized. They actively participate to the improvement of the working environment. This new attitude of WCM organization constitutes the basis of a durable improvement of the company's performance.

In an WCM management system the manager's primary tasks become leading the change, establishing a sense of trust and purpose within the organization. Since no single manager can be involved in all of the decisions, the continuity of an effective management depends much more on shared values than on superb analytical techniques. All workers of the company - from production workers, to managers, to professionals - need to be fostered and encouraged. Training employees provide them with skills, knowledge, and new attitudes whereby they can share common goals and efforts with management.

According to Schonberger (1986), human resources management is not based on top-down management or bottom-up management. It applies a bidirectional management effort, without relying only on top management. A synchronization between top management leadership and employees willingness to collaborate is needed.

WCM put great emphasis on employees involvement (EI). involving employees means to create a workplace in which they have an impact on decisions and actions that affect their jobs in broader area than their immediate job responsibilities. In other words it can be defined as the positive participation of the workforce to the improvement of working environment, product quality and productivity. EI is a management philosophy, rather than a goal or a tool. It enables workers to contribute to the continuous improvement and the ongoing success of their work organization.

EI acts primarily on the following dimensions (www.eiilmuniversity.ac.in):

- Power: to act and make decisions about work in all its aspects;
- Information: about processes, quality, customer feedback, event and business results;
- Rewards: tied to business results and growth in capability and contribution;
- Training: knowledge of the work, the business, and the total work system acquired through systematic training process.

Teamwork represents the best tool to create cooperative relationships, motivate employees, and involve them in problem-solving and decision-making. Participation is therefore achieved through employee involvement, teams, and employee empowerment. The two main goals to fulfill in a management system are: 1) to continuously improve working environment, and 2) to solve specific problems. (Owusu, 1999). There exist two different types of team to respond to these needs: functional teams and project teams. Functional teams are permanent team within a department. Their aim is to continuously improve working environment within the department. Project or cross-functional teams solve specific problems. They are composed of workers from different functional area and usually from different levels in the company hierarchy.

The rise of self-directed teams has influenced decision-making processes and organizational structures. WCM organizations have flatter structures in which decision-making is less unidirectional. Interactive processes tend to change intra-team dynamics from hierarchical to multi-directional.

People represent the resource on which is ultimately based an organization performance. Even if the right management systems plays an essential role, the capabilities to improve competitiveness come from people.WCM can produces its effects both in terms of productivity and quality only if there is a full involvement of people. Employees need to believe in the validity of this system, as well as the company needs to be willing to invest heavily on their skills training. So, by developing people potential WCM organizations can achieve a competitive advantage in a way that is difficult to be emulated for its competitors.

2. A CASE STUDY: FIAT CHRYSLER AUTOMOBILES

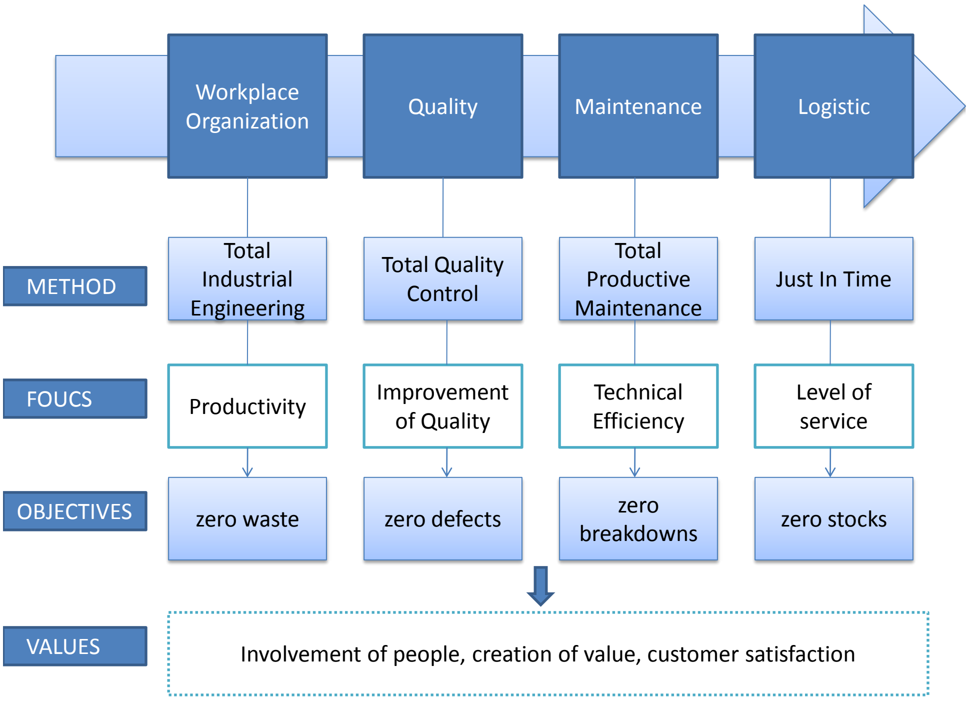
2.1 WCM implementation in Fiat Chrysler Automobiles

WCM was introduced in Fiat Group during the period 2003-2006 as a set of methods to which plants could join optionally. Since 2006 the implementation has been extended to all the plants of the group and WCM evolved from a project to a real production system. The diffusion to the entire factory came about through progressive steps, after a first phase in which the program was experienced in the model areas. Since 2009 WCM has been gradually adopted also in Chrysler's plants and transferred to the main suppliers. WCM program has been developed under the guidance of prof. HajimeYamashina and Luciano Massone and implemented in all plants after a rigorous conceptual systematization.

The WCM Development Center is in Torino, where new methodologies are developed and tested working in close collaboration with the universities. The Manufacturing Training and Consulting Team is the group of "professional trainers" responsible for transferring WCM best practices and know-how to all sectors of FCA around the world, as well as amongst suppliers and external partners who belong to the WCM Association. WCM Academies are the places where employees learn, according to an interactive approach, to use the tools and methods of WCM.

FCA has customized the WCM approach to its needs with Prof. Yamashina. The WCM program made by Yamashina is shown here below in Table 2.1. The main innovation introduced in the classic WCM models regards the inclusion of Total Industrial Engineering (TIE) that joins JIT, TQC and TPM in the new interpretation given by Hajime Yamashina, first within the WCM Association, and subsequently for FCA.

Table 2.1: World Class Manufacturing in FCA



Fiat Auto Production System (FAPS) is a program of innovation which aims at achieving WCM standard of excellence, by radically changing the production system. It is a structured and integrated production system that encompasses all the processes of the plant - quality system, security, environment, maintenance, cost management, logistics - in a perspective of continuous evolution. This system is based on the systematic attack of all types of waste and loss, through the use of rigorous methods and standards. The goal is to continuously improve production performance, seeking a progressive elimination of the sources of waste, in order to ensure product quality and maximum flexibility in responding to customer requests. The new factory that comes from WCM is in constant evolution. With increasing complexity of the systems, there is always room for improvement. Continuous improvement applies to all the design phase, as well as to what has already been invented. For this reason the last factory is always the best, since it possesses the best practices deriving from previous experiences, and has some extra innovation that makes it different.

Results of continuous improvement off all parameters are attained through the involvement of all employees, regardless of their position in the organizational structure.

WCM engages the intelligence of all to give their contribution to continuous improvement. With the introduction of WCM suggestions have become a real value. Workers are involved in the design stage and some of their suggestions become projects for the improvement of efficiency and performance. Involvement of employees, so that everyone believes in the program, and investment on people competences development are the keys of the success. For this reason WCM has been introduced in the plants after a meticulous training of all employees to ensure that they properly adopted the philosophy and the tools needed for the rootedness of the method.

A methodological innovation that is adopted with respect to the classical models of WCM is the clusterization of technical methods in ten technical and ten managerial pillars.

Moreover, an accurate performance control system is adopted. It is based on two kinds of indicators: Key performance indicators (KPI) and Key Activity Indicator (KAI). KPI measure classic productive performance (labor productivity, product quality rate, mean time between failures of a machine MTBF, etc.). KAI measure actions and effort needed to achieve an improvement goal (number of suggestions, kaizen made, etc.).

A final important aspect developed in the model FAPS is the audit system, highly evolved with respect to those required by previous models. The system constitute a fundamental management aspect in WCM implementation to control and consolidate the process of change. It includes two types of audit: self-rating audits, which are carried out by the local heads of the pillars and external audits, carried out and certificate by experts from the WCM Association. After external audits the plant receives a score that determines the WCM implementation level: *bronze* (50/59 scores), *silver* (60/69 scores), *gold* (70/84 scores), *world class* (85/100 scores).

2.2 WCM Pillars

FAPS is based on ten interlinking technical pillars (manufacturing process-related). Here below in Table 2.2 features for each technical pillars are illustrated. A seven step methodology is used to implement accepted solutions. Each pillar develops in 7 steps of improvement. Each steps is characterized by three phases: reactive, preventive and proactive. Each step specifies goals, activities, methods, tools and techniques that gradually increase in difficulty. They must be rigorously applied to advance in the path of improvement.

Table 2.2: Technical Pillars

Technical Pillars	Purposes
1. Safety	To reduce factors generating accidents. To develop a culture of prevention. To improve ergonomics in the workplace To develop professional skills.
2. Cost Deployment	To identify and reduce waste where activities can bring substantial benefits. To quantify the potential and expected economic results. To identify elimination methods.
3. Focused Improvement	To eliminate major wastes identified within the Cost Deployment pillar. To eliminate activities not generating value added To develop professional skills of problem solving.
4. Autonomous Activities (Autonomous Maintenance - Workplace Organization)	Autonomous Maintenance: To improve the efficiency of the global production system. To restore and maintain equipments to prevent deterioration. Workplace Organization: To develop a co-operation system between machine operators and maintenance service staff. To develop professional skills on products and plants.
5. Professional Maintenance	To increase machine efficiency using control and failure cause analysis. To foster collaboration with staff members responsible for Autonomous Maintenance. To increase qualifications of maintenance service staff.

6. Quality Control	To provide customers with high quality products at minimal cost. To develop proper operating conditions for production systems that ensure conformity over time. To increase quality and problem solving skills.
7. Logistic/Customer Service	To create favorable conditions for materials flow within the company and between the suppliers and the plant. To reduce inventory level. To minimize the amount of displacement and transit time inside the company, with direct deliveries from supplier to the assembly line. To integrate purchase, production and sales network.
8. Early Equipment Management	To ensure fast and stable start-up of new equipments. To design easily maintainable equipment. To reduce equipment life cycle cost (LCC).
9. People Development	To ensure appropriate skills and qualifications for every job position through a structured system of training. To prepare maintenance service staff and technicians to train later other employees. To spread knowledge and operational skills.
10. Environment	To comply with the requirements and standards of the environmental management. To improve the workplace through risk identification, prevention, and periodic internal audits verifying the impact of the plant on the surrounding environment.

Another important innovation introduced in the WCM program is the aggregation of the management aspects in ten managerial pillars in support of the technical pillars. They are: Management commitment, Clarity of objectives, Route map to WCM, Allocation of high qualified people, Commitment of organization, Competence of organization, Time and Budget, Level of details, Level of expansion, Motivation of operators.

2.3 Improving working conditions

This section focuses on the role of WCM in improving employees' condition of life and work. The content is the result of a series of qualitative interviews to FCA employees at different level of the organization. Respondents occupy the following roles in the factory:

- Shop stewards
- Workers
- Health, safety, and environment managers
- Safety managers
- Production system development manager
- Ergonomic engineer

2.3.1 Health, Safety, and Well-being

The principle of continuous improvement also extends to the quality of life and work. Health, safety, and well-being thus become key issues in a world class factory.

The first goal in terms of safety is to achieve zero accidents and to ensure the maintenance of working skills throughout the worker's life. At the beginning of the implementation of WCM the accident index was close to 2%, in some plants 3-4%. Today zero accidents are becoming regular: there are plants that have had no accidents for 2 or 3 years.

The strategy for the protection and promotion of occupational health and safety broadens to all areas of intervention and to any activity.

The comprehensive and systematic approach to health and safety issues is based on two main elements: preventive and proactive approach.

Risks are managed in a preventive approach through the continuous identification and evaluation of criticality. Risk factors that may arise as a result of the introduction of new substances, materials or technologies are continually monitored. Specific corrective action plans are then carried out, according to priority, to reduce potential risks.

The proactive approach consists in the active involvement of all employees in the improvement process. Employees are involved in activities focused on safety through targeted training actions and initiatives aimed at increasing their awareness. These activities are integrated by a structured system for the collection of suggestions. Thanks to the cooperation of employees, the analysis of unsafe conditions and behaviors allows an effective detection of problems before they arise.

At various organizational levels a number of key performance indicators are defined to determine the effectiveness of actions and procedures taken to promote safety in the workplace.

The greater attention to cleanliness and order of the workplace provides a healthier environment, reducing the risk of accidents. The commitment to health and safety is also reflected in the application of strict standards of safety and ergonomics in the design of plants and equipments. The reduction of musculoskeletal problems is taken into consideration during the design phase of cars and workstations. In such a phase workers are involved so that they can point out problems that may arise on workstations. The development of a culture of prevention of health and safety, together with the diffusion of safe behaviors in the workplace are pursued by FCA through investment in training. As part of the safety pillar of WCM, specific organizational structures guarantee the planning and implementation of awareness campaigns and training programs. These activities focus on protecting health and safety, and promoting appropriate safe behaviors at any levels and functions within the organization. Workers are trained to ergonomic and safety principles. Initially widespread in Italy in 2011, information tools and training programs have been shared by the specialists of the function Environment, Health and Safety (EHS) all over the world.

In 2012, the Organismo Paritetico Health and Safety (OPHS) has developed a number of courses related to health and safety at work as part of the training platform Health and Safety First. OPHS is a joint entity composed of Fiat S.p.A., Fiat Industrial S.p.A., Unione Industriale di Torino and the trade unions FIM-CISL, UILM-UIL and FISMIC. It was founded in 2011 with the aim of establishing the training tools for safety, moving from a formal training related to law compliance, to a more oriented to behavioral change. The goal of the platform Health and Safety First is to ensure a joint governance of training programs and the most important activities with impacts on the

management of employees, in addition to proposing solutions to the critical issues related to health and safety at work.
For each type of training there is a semi-guided learning phase of risks. In other words, the worker has a personal experimentation of the risks related to his activities, through a semi-autonomous training. Training is moving towards an approach that allows you to learn directly on the job, thus promoting greater consciousness raising of the risks. Such a model has proved particularly effective for the continuous update of workers for what concern the proper use of personal protective equipment, safety procedures and behaviors required in the workplace.

The protection of occupational health and safety does not end in the reduction of accidents, elimination of risks and promotion of a proactive behavior. In a broader approach to health and safety, the goal is extending to the overall psycho-physical well-being of the individual.

In line with this objective, projects that contribute to spread a culture of health and disease prevention have been set up through the promotion of healthy habits, medical checks, wellness programs and sports activities. An example of these programs concerns alimentation. Alimentation has been improved through specialist doctors and nutritionists who promoted the adoption of healthy eating habits and lifestyles. The program includes initiatives such as losing weight, medical screening, access to fitness facilities, nutrition education, improvement of canteen quality. Workers' health change is measured through statistics on changes in dietary habits, canteen consumption, weight change compared to the years, etc. After data analysis, corrective factors are made. Programs are first tested in a few "pilot" plants. At the end of the trial phase the best practices for each area of intervention are defined. Then, after the standardization the model is diffused among the other plants involved in the development of the pillar.

2.3.2 Ergonomics

The ergonomic design of workplace prevent occupational accidents and diseases, such as strains, sprains, tears, and musculoskeletal disorders, thus improving the quality of work. Ergonomics is not a pillar in itself in FAPS. Its indicators converge in Safety and Workplace Organization pillars.

FCA pays particular attention to the ergonomics in the organization of production processes, the design of workplaces, and the choice of machinery and equipment. The aim is to reconcile employees' welfare with the improvement of production capacity. The increased attention of FCA to the improvement of the ergonomic design is essentially due to two factors:

a) compliance with legal requirements for the prevention of musculoskeletal disorders, (d.lgs 81/2008, Testo unico sulla salute e sicurezza sul lavoro);

b) adoption of a WCM system whose goals also includes the improvement of safety.

The main actions undertaken to reduce the risk of musculoskeletal disorders are related to the ergonomic design of work stations. Risk assessment is continuously updated and corrective measures at technical or organizational level are adopted. During 2012, Ergo-Uas methodology has become operative. Such a system is a scientific model, based on international parameters and standards, for the control of workload and productivity. It combines the definition of metric of work (time and methods) with ergonomic aspects. It is designed to increase both the productivity of the company and the protection of workers' health. On the one hand the system measures working time and methods. On the other it assess biomechanical risk for workers' health due to manual handling of loads and repetitive strains.

In 2012, an innovative ergonomic laboratory was created in Turin. There, work conditions and segments of the production lines are replicated. The laboratory allows to perform a more sophisticated measurement of the workstation ergonomics. Some of the main measurement tools in use since 2010 include: swivel hook, welding pincers, lifters, bench with adjustable altimetries.

In collaboration with the CRF (Centro Ricerche Fiat), advanced methods for the analysis of workstation ergonomics have been developed. For example, a system of movement sensors (cables, bands, wires) is used to measure movements and forces. By placing sensors on workers' body it is possible to calculate all the factors that impact on the ergonomic index, such as movements, angles, indexes, permanence time. An innovative application designed by FCA is the use of sensing gloves as measuring system. They are piezoresistive sensors born in the medical field that allow to measure

the strength of all types of pinch through the pressure exerted.
All workstations and operator activities are also verified through virtual simulations.

A great innovation introduced from 2010 concerns the involvement of workers in the design phase of the ergonomics of workstations. Some team leader workers attend the ergonomic process by voicing their concerns and suggestions for reducing exposure to risk factors and by evaluating the changes made as a result of an ergonomic assessment. The design phase is then enriched by the direct experience of workers who know workstations and activities of the line. When excessive ergonomic loadings that do not respect the law emerge, workstation are redesigned. Designs change continuously up to technical and technological limits.

Activities carried out in the laboratory allow to correct any ergonomic concern before that workstation are realized. Ergonomics, thus, takes place ex ante, in order to be able to modify the projects. Ex post, ergonomics is measured on the worker index of risk(number of movements made with his hands, how many times he does the pinch, how many times he raises his arms, etc.). If ex post there still is an ergonomic risk, one can intervene only organizationally (changing the worker, rotating, training him if cycles and sequences are wrong, etc.). For heavy and bulky objects there is a partner that takes and places them, while the worker does assemblies.

Special attention is devoted to the development of workstations and equipments suited to heterogeneous anthropometrics characteristics of employees. Design is made on the average heights of population. If at this stage posture and altimetry problems emerge, digital modeling tools and simulations carried out with virtual modeling of the human body are used for the 5th and 95th percentile. Where it is not possible to adjust the workstation, workers are assigned to workstations by matching their characteristics. For this purpose a software that crosses workstations with anthropometric characteristics and code of limitation has been developed. In this way, a workplace that better fits to the physical characteristics of each employee is set up.

3. WCM IMPACT ON OCCUPATIONAL HEALTH AND SAFETY

An empirical study to test WCM impact on employees' well-being is carried out in this chapter. The aim of the study is to estimate the relationship between WCM implementation and employees' perceived level of health and safety at work. The impact is examined using a multinomial logistic model with dataset on employees of FCA Italian plants.

The chapter is organized as follows. Section 3.1 presents a brief review of the literature of the impact on employees of the reorganization of work. Section 3.2 describes data and variables that are used in the analysis. In section 3.3 the econometric model adopted is briefly illustrated and the results of the estimation are presented.

3.1 Literature review

Although technological and organizational innovations have received increasing attention with regard to the relationship between new production methods and performance results, their impact on workers' conditions of work and well-being has not received the same attention. Studies on the impact of organizational changes on productivity and competitiveness have almost ignored the effects on employees. The theme of workers' opinions is rarely deepened, especially for what concern health dimension in employees' well-being.

Several disciplines have attested the importance of work organization as a determinant of workplace health and safety; however, the scientific literature provides relatively few examples of occupational health and safety interventions due to the re-organization of work. Moreover, most of the researches are based on small samples that make results difficult to generalize.

To the extent that job satisfaction is related to various work attitudes and features, it has been widely used as an indicator of a person’s quality of work life. In particular, the majority of the researches on new models of work organization has been conducted on the relationship between job satisfaction and human resources management practices. HRMP are believed to determine higher level of job satisfaction as workers most likely have greater opportunity to participate in the decision-making process, higher level of communication with co-workers, increased trust towards the company. Other practices such as job rotation, team work, reward, empowerment and employee development might as well increase workers' job satisfaction. The analysis conducted by Freeman et al. (2000) found that the higher employee involvement generated by innovation (suggestions, skill development, team work) was associated with substantial improvements in the work lives of employees. Instead, when considering autonomy many workers feel that it was not sufficient because of the behavior of the middle management. In line with these results Bauer (2004) found that workers particularly value the opportunities associated with these innovative systems, such as increased participation, improved communication and also increased autonomy in performing their tasks. Conversely, being involved in team work and job rotation as well as supporting human resource practices appear to contribute relatively little to increase job satisfaction. Team work and job rotation are found to increase significantly job satisfaction by Gürbüz (2009). He found the same positive correlation with other human resources practices such as empowerment and participation (that had the major impact on the dependent variable). HRMP are confirmed to be a positive strategy in terms of more satisfied workers by another research (Ray I. A. and Ray S., 2011) which found particular support for performance appraisal and participation.

Likewise, lean production models have been described as beneficial for employees. However, according to the literature that investigate the impact of lean production on job satisfaction and health, results appear controversial from the point of view of human well-being. Several studies identify negative effects deriving from the implementation of practices such as continuous improvement, just-in-time, total quality management, team working, job rotation, computer-based technology. Lewchuket al., (2001) found no improvement in the quality of work life or empowerment. Workers suggested that working conditions in automobile assembly plants continued to expose them to serious health and safety risks. In another study (Parker, 2003) employees were negatively affected by the implementation of lean production practices, especially those in assembly lines, with reduced organizational commitment, job autonomy, skills utilization, participation in decision making and increased job depression. Reorganization of work generally leads to poor quality jobs also in the research by

Østhus (2007), in which it resulted related to high work demands, job insecurity, work related health problems, low job satisfaction and an effort–reward imbalance. Worsening effects on workers' attitudes (job satisfaction, health and intention to stay) caused by lean work organization practices (delegation of responsibilities, standardization, job rotation) are reported in the research by Bouville and Alis (2014). Only quality management had a beneficial influence on employees' health at work.

In his qualitative research Vidal (2007) highlights the role of individual work orientations in determining worker satisfaction. Since job satisfaction appears as multifaceted and individual work preferences unstable and context-dependent, an increase in employees involvement does not necessarily increase satisfaction. Most of the workers were not enthusiastic of increased responsibilities of lean production inasmuch as they often generated more stress and frustration.

Among the studies which reported positive consequences, Seppälä and Klemola (2004) found that the effects of lean implementation were mostly positive from the point of view of job content and the quality of work because they had increased opportunities for participation, worker control, and learning. Technological and organizational changes brought more responsibility and development opportunities for all employees. Sim, Curatola and Rogers (2011) emphasized the importance of perceived organization support, training and empowering in the successful implementation of lean production in the studied company. In particular, perceived organization support seemed to matter on job security, effort-reward fairness and job satisfaction.

If we consider studies on WCM there are two qualitative research that analyze its impact on employees' well-being. Even if they shed light on contrasting results, both of them identify the importance for the perception of participation level of the way managers apply WCM.

Haynes (1998) analyzed WCM impact in relation to three practices: just in time, functional flexibility and team work. From the study emerged a substantial workers' dissatisfaction on all the dimensions. In employees' opinion, JIT resulted in an increase of work intensity and effort since the increased efficiency of the system forced them to increase the work pace; functional flexibility had not enriched their work neither with more challenge nor with more satisfaction; and team work was perceived as a strategy to create competition rather than cooperation.

A more recent research (Sidiqui, Allison and Cox, 2013) reported more positive effects. Results highlighted the development of a culture of communication and participation. The high popularity of the innovation among workers produced a strong identification between the employees and the company. WCM implementation generated a change in the organizational culture (from hierarchical structures to more decentralized and participatory) through practices such as team work, empowerment, suggestions, skills improvement.

Another study on WCM, that is both qualitative and quantitative (Cipriani et al., 2014), reported both positive and negative results. Improvement of safety and workplace, as well as team work and suggestions emerged among the most appreciated changes. Conversely, more negative perceptions were found on working time, stress, effort, feedback, and reward-fairness. A substantial difference on workers' perceptions emerged depending on the level of implementation. Only when fully developed, the WCM model appeared to be thoroughly appreciated by employees.

Table 3.1: Literature review.

Author	Case study	Period	Dep. Var.	Impact	Source
Richard B. Freeman, Morris M. Kleiner, Cheri Ostroff (2000)	Firms, USA	1994-1995	Well-being	Employee involvement (suggestions, skill development, team work): +	National Bureau of Economic Research
Thomas K. Bauer (2004)	EU-member countries	2000	Job satisfaction	Workers involvement in HPWO: +	Institute for the Study of Labor (IZA) in Bonn

SaitGürbüz (2009)	Employees, Istanbul	N/A	Job satisfaction	Participation: + Empowerment: + Job rotation: + Self-directed work teams: +	Istanbul University Journal of the School of Business Administration
Ishita Aditya Ray and Sarbapriya Ray (2011)	Iron and steel firms, India	N/A	Job satisfaction	Performance appraisal: + Participation: + Training: + Development: + Empowerment: + Compensation: +	Public Policy and Administration Research
Lewchuk, W., Stewart, P. and Yates, C. (2001)	Automotive Industries, Canada-UK	1996, 1997	Employee control Work load Health-Safety Management policies	Negative effect of lean production	New Technology, Work and Employment
Sharon K. Parker (2003)	Manufacturing company, UK	3-year period		Negative effects of lean production	Journal of Applied Psychology
Seppälä, P. and Klemola, S. (2004)	Manufacturing companies, Finland	1999-2001	Job satisfaction Involvement Stress	Developing opportunities: ++/ Social climate: + / / Quantity of work: / / + Change management: / + - Job security: / + /	Human Factors and Ergonomics in Manufacturing
Matt Vidal (2007)	Firms, Wisconsin USA	N/A	Job satisfaction	Different effects depending on individual work orientations	Critical Sociology
StåleØsthus (2007)	Employees, Norway	2003	Task discretion Work demands Job insecurity Health problems Job satisfcation	Reorganization: / + + + -	Work, employment and society

Khim L. Sim, Anthony P. Curatola and John W. Rogers (2011)	Manufacturing company, US	N/A	Job satisfaction Job security Effort-reward fairness	Organizational support: + + + Training: + / / Effort-Reward Fairness: - / /	Conference Proceedings for the Northeast Region Decision Sciences Institute
Bouville, G. and Alis, D. (2014)	Employees, France	2002-2003	Job satisfaction Health Intention to stay	Responsibility: - - - Standardization: - - - Problem solving: / - / Job rotation: - - - Quality management: - + -	The International Journal of Human Resources Management
Amanda Haynes (1998)	Multinational manufacturing plant, Ireland	1996		Negative effects of WCM	European Journal of Training and Development
Sidiqui, Allison and Cox (2013)	Manufacturing company, Italy	N/A		Positive effects of WCM	European Foundation for the Improvement of Living and Working Conditions
Cipriani A., Erlicher L., Neirotti P., Pero L., Campagna L. (2014)	Automobiles company, Italy	2013		Positive and negative effects of WCM	Associazione italiana Ingegneria Gestionale

Note: + - / refer to the impact of the covariates on the dependent variables: positive (+), negative (-), no impact (/).

3.2 Sample and descriptive statistics

Data analyzed come from a cross-sectional survey conducted by FIM CISL trade union in 2013. The aim of the research was to find out WCM impact on factory work conditions and organization. For this purpose, the research has mainly focused on workers perceptions and opinions. Research objectives focused on the three following areas.

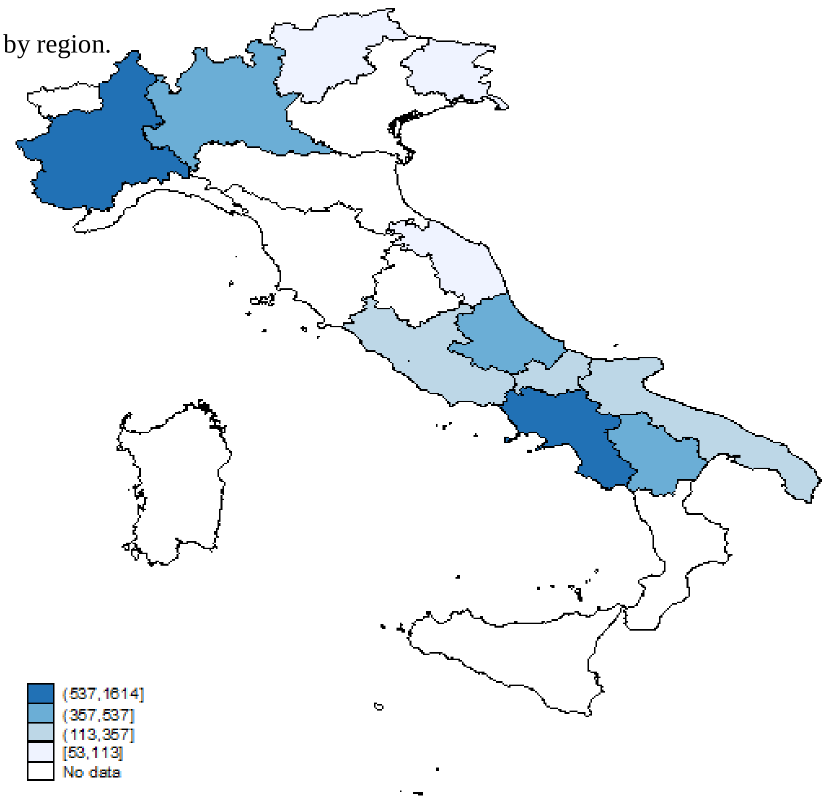
• The change of working conditions, such as work station, safety, effort, ergonomics, environmental conditions, relationships with colleagues and leaders.

• New forms of employee participation, in particular team work, training and suggestion for improvement.

• The stages of change and the opinions of workers at each stage.

The survey was conducted in both qualitative and quantitative way. The quantitative survey was carried out with a closed answer questionnaire to 5.035 employees in 30 Italian plants. A 5 points Likert scale was adopted for closed answers. 6 plants in which respondents were not representative were excluded from the sample, together with those questionnaires which were incorrectly answered. The resulting sample consisted of 4714. Figure 3.2.1 shows how observations are distributed within the 11 regions in which the 24 plants are located. Table 1 in Appendix contains the list of the plants and the observations.

Figure 3.2.1: observations distribution by region.



The analyzed sample consists of 4714 employees, 81.04% of whom are men. Table 3.2.1 sums up sample main characteristics. Most of the population has Italian nationality; foreigners represent 0.81 % of the pool. The average age is 44 years for men and 43 years for women. The sample is mainly distributed in the age class between 35-45. On average workers have 19 years of seniority (18 for women). Most employees have a middle or high school degree or a vocational qualification. Most employees are direct workers (65.21%) and work in the assembly unit (61.39%). Most women work in assembly unit (67.67% of women), however the highest employment rate for women workers is in the painting unit (26.16% of painting workers).

Table 3.2.1: Sample characteristics.

Gender		**Population**	4714
Men	81.04%		
Women	18.96%	**Unit**	
Age class		Bodywork	15.59%
23-34	12.32%	Painting	8.68%
35-45	42.07%	Assembly	61.39%
46-55	38.86%	Staff	0.93%
56-67	6.75%	Other	13.41%
Seniority class		**Role**	
0-18	48.62%	plant conductor	8.93%
19-36	50.06%	direct worker	65.21%
37-46	1.32%	indirect worker	8.57%
Qualification		team leader/team expert	3.59%
elementary school	1.95%	bunkering/forklift driver/logistician	5.13%
middle school	43.83%	technologist	0.89%
vocational	18.60%	maintainer	3.84%
high school	34.94%	other	3.84%
university	0.68%		

Variables used in the analysis can be classified into three groups: socio-demographic, WCM-related, and well-being variables.

Socio-demographic variables include: gender, *gen*, which assumes value of 1 if woman, zero otherwise; age, *age*; qualification, *qualification*, a dummy variable that assume value of 1 if the scholar qualification is greater or equal to high school diploma and 0 otherwise. Moreover, in order to capture the role of unit, we used *unit*, which assumes value from 1 to 5 depending on whether the employee belongs to bodywork, painting, assembly, staff, or other unit respectively.

WCM-related variables are formed by some of the main practices introduced with WCM implementation: *rotation*, which assumes values from 1 to 5 depending on whether the worker turns on one, two, three, four, or more stations; *team*, that refers to the perception of being in a team; *sugg* that are suggestions provided by the employees; *feedback*, which refers to the feedback received for suggestions; *audit*, which assumes value from 0 to 3 relative to zero, bronze, silver, and gold phases. As mentioned in chapter 2, audit represents an assessment scale to control the progress of the innovation process. The score varies from 0 to 100 and summarizes the assessment of an external audit carried out by specialized inspectors from the WCM Association. The evaluation is based on the standards set forth by the 20 WCM pillars (10 technical and 10 managerial). Each pillar has a weight equal to 5. After external audits the plant receives a medal that represents the WCM implementation level: *bronze* (50/59 scores), *silver* (60/69 scores), *gold* (70/84 scores), w*orld class* (85/100 scores). With the exception of audit, the other variables assume value from 1 to 5 according to a Likert scale.

A third group of variables composed by the items related to well-being include: *health_safety*, which capture the improvement of health and safety aspects; *workplace*, which capture the improvement of workplace (cleanliness, lightness, noise); *stress*, which asks if work time is less stressful; *effort*, which asks whether the effort has decreased; *break*, which express satisfaction with the break system; *cog_effort*, which asks whether the cognitive effort has increased. All these variable assume values according to the Likert scale.

Variables are summarized and described in Table 3.2.2

Table 3.2.2: Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
gen	4714	0.1896479	0.392064	0	1
age	4714	43.92448	7.614368	23	67
qualification	4714	0.3561731	0.478918	0	1
unit	4714	2.878871	1.114288	1	5
rotation	4583	2.584333	1.529369	1	5
team	4574	2.985133	1.466365	1	5
sugg	4586	3.380506	1.443144	1	5
feedback	4509	2.689732	1.483938	1	5
audit	4714	1.446966	0.836678	0	3
health_safety	4641	3.405301	1.426854	1	5
workplace	4620	3.546753	1.417188	1	5
stress	4640	2.556897	1.372204	1	5
effort	4646	2.770555	1.442654	1	5
break	4593	2.90921	1.403482	1	5
con_effort	4557	3.010314	1.469362	1	5

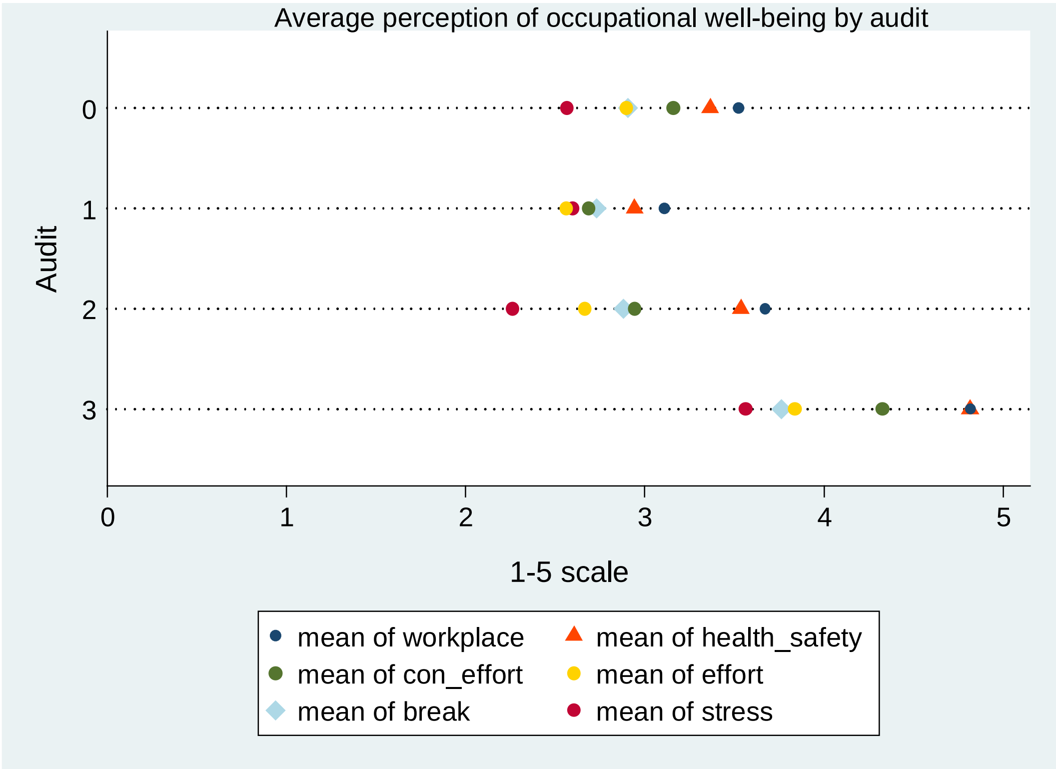
Table 3.2.3 shows a summary of the results by correlating employees' perceptions expressed in the survey with the assessment expressed through the audit score. Perceptions are investigated using six variables related to health and safety. For each level of audit the percentage of "strongly agree" answers is calculated.

Table 3.2.3: Percentage of "strongly agree" answer by audit.

Audit	health_safety	workplace	effort	stress	con_effort	break
Zero	22.63	25.88	12.79	8.33	18.76	10.72
Bronze	14.91	18.73	8.53	11.01	13.75	10.41
Silver	23.35	30.40	12.52	7.22	16.70	13.57
Gold	85.33	84	37.09	21.29	56.98	37.72

The table shows that in the early stages of WCM implementation there is no substantial difference in employees' perceptions. A clear trend of evolution does not emerge. Conversely, for some variables the bronze stage is the one in which perceptions are less positive. Only the gold level is considerably separated from the others, with much more positive perceptions of health, safety and workplace improvement. Graph 3.2.1 shows graphically these trends.

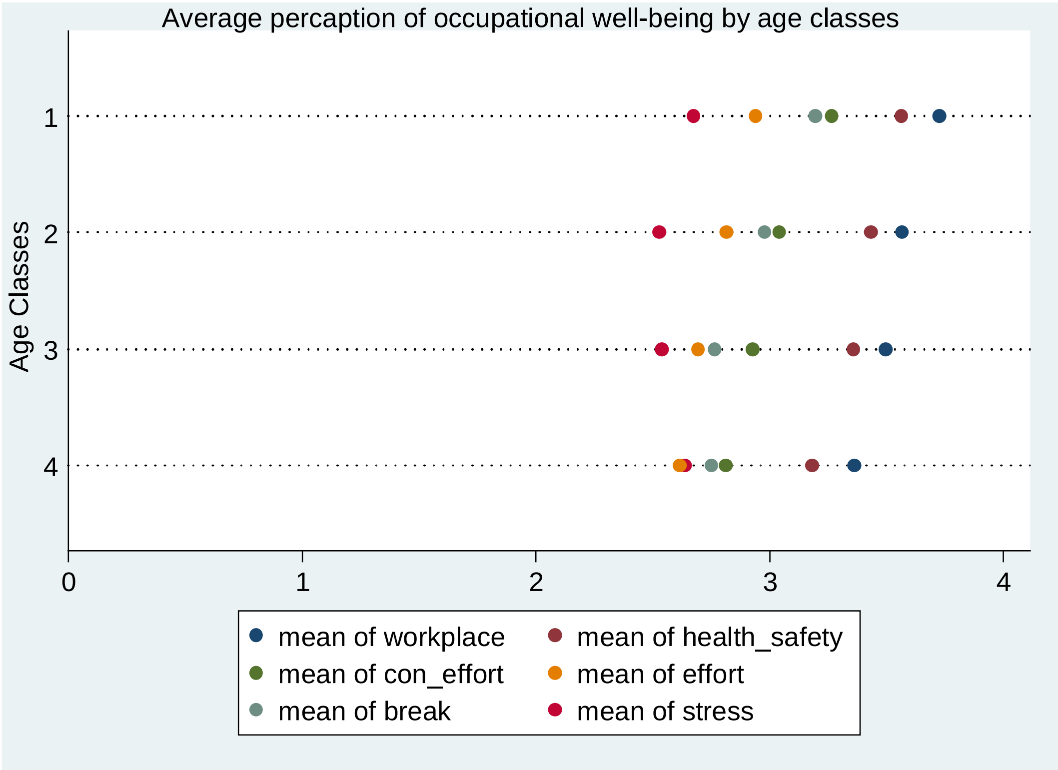
Graph 3.2.1Well-being perceptions by audit.



For some specific variables, such as effort, stress, and break system, perception of improvement is not high even in the gold stage. 37.09% of workers with gold audit perceive a decrease in effort, 21.29% perceive an improvement in stress, and 37.72% are satisfied with the new system of breaks. In the early stages these variables have low rates. As regards the cognitive load it seems to increase particularly in the most advanced stage.

Perceptions on well-being appear to be negatively associated with age (graph 3.2.2).

Graph 3.2.2: Well-being perceptions by age classes.



Note: classes of age 1, 2, 3, 4, refer respectively to 23-34, 35-45, 46-55, and 56-67.

With the exception of stress, younger workers perceive a greater improvement of workplace and effort and are generally more satisfied with the system of breaks.

There is no significant difference in well-being perceptions between women and men.

3.3 Multinomial Logistic Regression

The aim of this section is to test the impact of WCM implementation on employees' perceptions of health and safety. To the extent that no theoretical model exists, in addressing the question we refer to the previous literature on work innovation and employees' well-being. We set as dependent variables the perception of health and safety. Our covariates represent some of the dimensions related to organizational innovation usually associated with employees' well-being in the literature. They are WCM-related variables, in addition to the socio-demographic ones, that have been described in section 3.2.

In particular we want to test the existence of a relationship between the level of audit and the perceived level of occupational health and safety. Additionally, we want to test whether health perception is influenced by gender or age.

3.3.1 Description of the model

Multinomial logistic regression models how a categorical outcome variable y depends on a set of explanatory variables $\mathrm{X} = (\mathrm{x}_1, \mathrm{x}_2, \dots, \mathrm{x}_\mathrm{k})$. The explanatory variables can be continuous, discrete, or both and the log odds of the outcomes are modeled as linear combination of the predictor variables.

Consider the outcomes 1, 2, 3, . . . , M recorded in y, and the explanatory variables X. In a multinomial logistic regression one of the response categories is nominated as a baseline or reference cell, the log odds for all other categories relative to the baseline is calculated, and then the log odds become a linear function of the predictors. When there are m categories of the response variable, the model consists of $\mathrm{m} - 1$ logit equations which are fit simultaneously. As suggested before, in our model health_safety assumes five values ($m = 5$): "strongly disagree", "disagree", "don't know", "agree", "strongly agree". The values of the dependent variable y are then said to be unordered or nominal. In fact, although the outcomes are coded 1, 2, 3, 4, 5, the numerical values are arbitrary since the preferences cannot be ordered. Most of the variables used in the model have the same property. Thus, when analyzing data, these variable are treated as dummies.

This unordered categorical property of y distinguishes the use of multinomial logistic regression.

Let $\Pr(y = m)$ denote the probability that the i-th response falls in the m-th category. In the multinomial logit model, a set of coefficients, β^1, β^2, β^3, β^4, β^5corresponding to each outcome are estimated:

$$\Pr(y = 1) = \frac{e^{X\beta^1}}{e^{X\beta^1}+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.1}$$

$$\Pr(y = 2) = \frac{e^{X\beta^2}}{e^{X\beta^1}+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.2}$$

$$\Pr(y = 3) = \frac{e^{X\beta^3}}{e^{X\beta^1}+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.3}$$

$$\Pr(y = 4) = \frac{e^{X\beta^4}}{e^{X\beta^1}+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.4}$$

$$\Pr(y = 5) = \frac{e^{X\beta^5}}{e^{X\beta^1}+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.5}$$

The model, however, is unidentified in the sense that there is more than one solution to β^1, β^2, β^3, β^4, β^5 that leads to the same probabilities for $y = 1, y = 2, y = 3, y = 4, y = 5$. To identify the model, one β^m is arbitrarily set equal to 0 - it does not matter which. In our model we set $\beta^1 = 0$. The remaining coefficients measure the change relative to the $y = 1$ group. Setting different coefficients equal to zero leads to different interpretations of the coefficients, but the predicted probabilities for y = 1, 2, 3, 4, 5 will still be the same.

Setting $\beta^1 = 0$, the equations become:

$$\Pr(y = 1) = \frac{1}{1+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.6}$$

$$\Pr(y = 2) = \frac{e^{X\beta^2}}{1+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.7}$$

$$\Pr(y = 3) = \frac{e^{X\beta^3}}{1+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.8}$$

$$\Pr(y = 4) = \frac{e^{X\beta^4}}{1+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.9}$$

$$\Pr(y = 5) = \frac{e^{X\beta^5}}{1+e^{X\beta^2}+e^{X\beta^3}+e^{X\beta^4}+e^{X\beta^5}} \tag{3.10}$$

Then, for example, the relative probability of $y = 2$ to the base outcome is

$$\frac{\Pr(y=2)}{\Pr(y=1)} = e^{X\beta^{2}} \tag{3.11}$$

Let's call this ratio the relative risk, and let's further assume that X and $\beta_k^2$are vectors equal to$(x_1, x_2, \ldots, x_k)$ and $(\beta_1^2,\ \beta_2^2, \ldots,\ \beta_k^2)'$, respectively. The ratio of the relative risk for a one-unit change in x_i is then:

$$\frac{e^{\,\beta_1^2 x_1 + \cdots + \beta_i^2 (x_i+1) + \cdots + \beta_k^2 x_k}}{e^{\,\beta_1^2 x_1 + \cdots + \beta_i^2 x_i + \cdots + \beta_k^2 x_k}} = e^{\,\beta_i^2} \tag{3.12}$$

Thus, the exponentiated value of a coefficient is the relative-risk ratio for a one-unit change in the corresponding variable (risk is measured as the risk of the outcome relative to the base outcome).

Our model assumes the following functional form:

$$health\_safety = f(audit, gen, age, qualification, unit, rotation, team, sugg, feedback)$$

3.3.2 General results

Results of the multinomial regression are presented in table 2 in Appendix. The relative multinomial log odds of answering "disagree" vs. "strongly disagree" steadily decreases by moving from the lowest level of audit (zero) to the higher levels (bronze, silver, gold). The relative log odds of answering "don't know" decreases by 0.337 by moving from audit zero to audit bronze, while it increases by moving to audit silver (0.068) and gold (1.8). The relative log odds of answering "agree" rather than the baseline decreases by 0.237 by moving from audit zero to audit bronze. It increases by 0.65 and 1.999 by moving to audit silver and gold. The relative log odds of answering "strongly agree" vs. "strongly disagree" decreases by 0.566 by moving from audit zero to audit bronze; it increases by 0.316 and 3.501 by moving from audit zero to audit silver and gold.

With an increase of one year in age, the log odds of being in another category vs. "strongly disagree" would be expected to increase but not significantly. The values of coefficients in all categories are close to zero.

The relative log odds of answering "disagree" or "agree" slightly decreases by moving from low school qualification to high qualification. On the contrary, the log odds of answering "don't know" or "strongly agree" increases by 0.197 and 0.192.

Even if there is no uniform trend within the unit, the relative log odds of being in another category rather than the baseline decreases everywhere when moving from the bodywork to the painting unit. Conversely, it increases in all categories with the exception of "don't know" when moving from the bodywork to the assembly unit.

For what concern rotation, we can observe that the log odds of being in another category generally increases with the increase of the number of stations on which a worker turns (with the exception of "don't know"). This doesn't happen when workers rotate on more than four stations. In such a situation the log odds of being in a different category rather than the baseline always decreases.

Only for the category "strongly agree" (and partially for "agree") the log odds of not answering "strongly disagree" increases steadily as the perception of being in a team increases.

Giving suggestions shows no clear impact on the relative log odds. Receiving feedback for suggestions has a positive and steadily increasing impact on the log odds of not answering "strongly disagree" only for the category "strongly agree".

3.3.3 Health and safety perceived by gender

Assuming that men and women could answer differently to WCM changes, we repeated the same analysis relatively to gender dimension. The heterogeneous distribution of women within the plants makes this investigation worthy (table 3.3.1). Indeed, different behaviors between men and women in the way they answer to WCM implementation may translate into different organizational and managerial choices.

Table 3.3.1: women distribution within the plants

Plant	% women	Plant	% women
FGA Mirafiori Carrozzeria	34.97	Iveco Suzzara	27.40
FGA Maserati Grugliasco	43.14	CNH Jesi	19.82
FGA Mirafiori Meccanica	21.90	CNH Lecce	2.68
FGA Miafiori Presse e Stampi	4.44	CNH S. Mauro	1.89
FGA Verrone	8.81	MM Corbetta	57.78
FGA Cassino	22.41	MM Lighting Venaria	40.70
FGA Pomigliano	24.51	MM S. Benigno	24.49
FGA Termoli	24.54	MM Tolmezzo	39.62
FPT Foggia	0.49	Pratola Serra	28.44
FPT Iveco Torino	2.25	Sata Melfi	15.40
Iveco Brescia	9.60	Sevel V. di Sangro	19.50
Iveco Bolzano	10.62	Teksid Carmagnola	2.17

Before analyzing separately men and women, we performed the F tests to examine whether the coefficients of the equations are statistically equal for men and women. If this is true, then the null hypothesis H_0 is accepted. The results are presented in Table 3.3.2.

Table 3.3.2: F test for gender.

Variable	F	Prob> F	H_0	p-value
audit	270.99	0	rejected	0.001
qualification	7.96	0.0931	rejected	0.02
age	21.22	0.0003	rejected	0.001
unit	32.59	0.0084	rejected	0.01
rotation	56.48	0	rejected	0.001
team	492.08	0	rejected	0.001
sugg	100.62	0	rejected	0.001
feedback	380.56	0	rejected	0.001

From the significant values we can conclude that the null hypothesis H_0 is rejected for each variable. The two coefficients are not jointly equal to zero.

Results of this paragraph are reported in Table 3 and 4 in Appendix.

The relative log odds of answering "disagree" rather than "strongly disagree" decreases as the audit level rises for both men and women. At each level of audit, the log odds decreases more for women than for men.

The relative log odds of answering "don't know" decreases for men when moving from audit zero to audit bronze and silver, while it increases for women. Moving from zero to gold audit shows a big difference between men and women: the log odds increases by 18.404 for women and by 1.319 for men.

The relative log odds of answering "agree" decreases equally for both from moving from zero to bronze audit. It increases by 0.376 for women and 0.702 for men when moving to silver level. The largest difference is when moving to gold audit: the log odds increases by 16.178 for women and by 1.756 for men.

The log odds of answering "strongly agree" decreases by 0.113 for women and by 0.7 for men when moving from zero to bronze audit. It increases by 0.343 for women and by 0.285 for men moving to silver audit. The largest difference is when moving to the gold stage, where the log odds increases by 17.861 for women and by 3.209 for men.

The log odds of answering "disagree" slightly decreases for both when moving to higher level of qualification. The log odds of answering "don't know" when moving to higher level of qualification decreases by 0.567 for women and increases by 0.296 for men. The log odds of answering "agree" increases by 0.342 for women, while it decreases by 0.108 for men when moving from low to high qualification. The log odds of answering "strongly agree" increases for both, but more for women (0.278) than for men (0.2).

The relative log odds of being in another category rather than the baseline follows the same behavior for men and women when moving from the body work to the painting or assembly unit. However, with the exception of the category "strongly agree", the log odds generally has lower values for women in all the categories of answer. Moreover, a huge difference between men and women is the log odds of answering "agree" or "strongly agree" when moving from the bodywork to the staff unit. It increases respectively by 17.016 and 17.655 for women; while the relative log odds for men are 0.733 and 0.612.

Men and women answer differently to the increase of the perception of being in a team when answering "disagree" or "don't know" rather than the baseline. For the categories "agree" and "strongly agree" the log odds follows the same trend for both.

Relatively to rotation, the log odds of not answering "strongly disagree" always decreases for men when rotating on more than four station. For women it happens only for the category "agree".

For what concern suggestions women and men show different impacts especially for the categories "agree" and "strongly agree". However, there is no clear impact of suggestions on the relative log of not answering "strongly disagree" neither for men nor for women. Feedback shows no difference from the general results.

3.3.4 Health and safety perceived by age classes

The other dimension we decided to focus our analysis on is represented by age.

After we controlled for workers distribution by classes of age (≤ 36 and > 36), we found significant difference within the plants (table 3.3.3). In particular, younger workers appear not homogeneously distributed, but highly concentrated in some plants. As for women, this may lead to different implications in work management and organization.

Table 3.3.3: distribution of employees younger or equal to 36 years.

Plant	% < 36	Plant	% < 36
FGA Mirafiori Carrozzeria	0.00	Iveco Suzzara	22.60
FGA Maserati Grugliasco	2.45	CNH Jesi	9.91
FGA Mirafiori Meccanica	5.79	CNH Lecce	42.86
FGA Miafiori Presse e Stampi	2.22	CNH S. Mauro	22.64
FGA Verrone	8.81	MM Corbetta	35.56
FGA Cassino	46.50	MM Lighting Venaria	10.47
FGA Pomigliano	42.45	MM S. Benigno	2.04
FGA Termoli	13.89	MM Tolmezzo	1.89
FPT Foggia	4.93	Pratola Serra	8.26
FPT Iveco Torino	27.01	Sata Melfi	0.76
Iveco Brescia	10.40	Sevel V. di Sangro	31.29
Iveco Bolzano	15.93	Teksid Carmagnola	0.72

Results of this paragraph have been obtained by dividing the sample in two classes of age: less or equal to 36 and major than 36 years old. After we tested for many different classes of age, 36 has been individuated as the threshold upon and below which opposite perceptions are found with respect to the audit variable. Results of multinomial regression are in table 5 and 6 in Appendix.

At the beginning we performed the F tests to examine whether the coefficients of the equations are statistically equal for the two classes. The results are presented in Table 3.3.4. From the significant values we can conclude that the null hypothesis H_0 is rejected for each variable, with the exception of gender.

Table 3.3.4: F test for age classes.

Variable	F	Prob> F	H_0	p-value
audit	260.91	0	rejected	0.001
qualification	4.53	0.3387	rejected	0.975
gen	0.66	0.9641	accepted	0.975
unit	34.60	0.0045	rejected	0.005
rotation	56.47	0	rejected	0.001
team	492.01	0	rejected	0.001
sugg	103.25	0	rejected	0.001
feedback	379.82	0	rejected	0.001

Generally, results for all variables do not differ largely between the two classes of age. However, for audit variable, they completely differ. For younger employees the relative log odds of not answering "strongly disagree" always decreases at each level of audit for each category of answer to health and safety improvement. To this extent, they seem to have more negative perceptions.

On the contrary, for workers older than 36 the log odds increases most of the time. For the categories "don't know", "agree", and "strongly agree", the log odds of not answering the baseline decreases when moving from zero to bronze audit. For the category "disagree" it slightly decreases when moving to the silver level. For all the other categories and level of audit it increases. In particular, it sharply increases for each category of answer when moving from zero to gold audit (by 11.426, 13.934, 14.012, and 15.666).

For rotation younger workers in general show slightly higher values. The relative log odds of not answering "strongly disagree" is always decreasing when older workers rotate on more than four station; while it is not for younger. For them it decreases only for categories "disagree" and "agree", but the impact is lower than the impact for older (the log odds decreases, but less than the one for the older class).

For what concern team, suggestions, and feedback, no significant differences and clear trend emerged among the two groups.

3.3.5 Discussion

The chapter has empirically investigated the relationship between WCM and health status perception. When reviewing the literature we found that no certain conclusions can be drawn on the relationship between the introduction of WCM systems and employees' perceived benefit in terms of well-being. The implementation of a WCM model aims at improving the organizational efficiency. More recently, however, the introduction of WCM is also related to the compliance with legal requirements on the prevention of health and safety at work, (d.lgs 81/2008). To the extent that it impacts on workers well-being, we investigated the relationship between the level of implementation and the perception of health and safety.

To test the relationship we used a representative sample drawn by the FIM-CISL questionnaire on FCA Italian employees. Our results suggested that WCM plays a positive role on employees' conditions of work. In particular, the importance of the implementation level emerged.

The bronze stage appears the one in which perceptions are less positive. For each category of answer in the Likert scale the log odds of falling in a category from 2 to 5 relative to the baseline 1 is always decreasing. With the exception of the category "disagree ", the other categories show an increasing trend of the log odds by increasing the level of audit. The gold level appears considerably separated from the others, since the log odds of answering "strongly agree" rather than "strongly disagree" increases by 3.501 by moving from audit zero to audit gold.

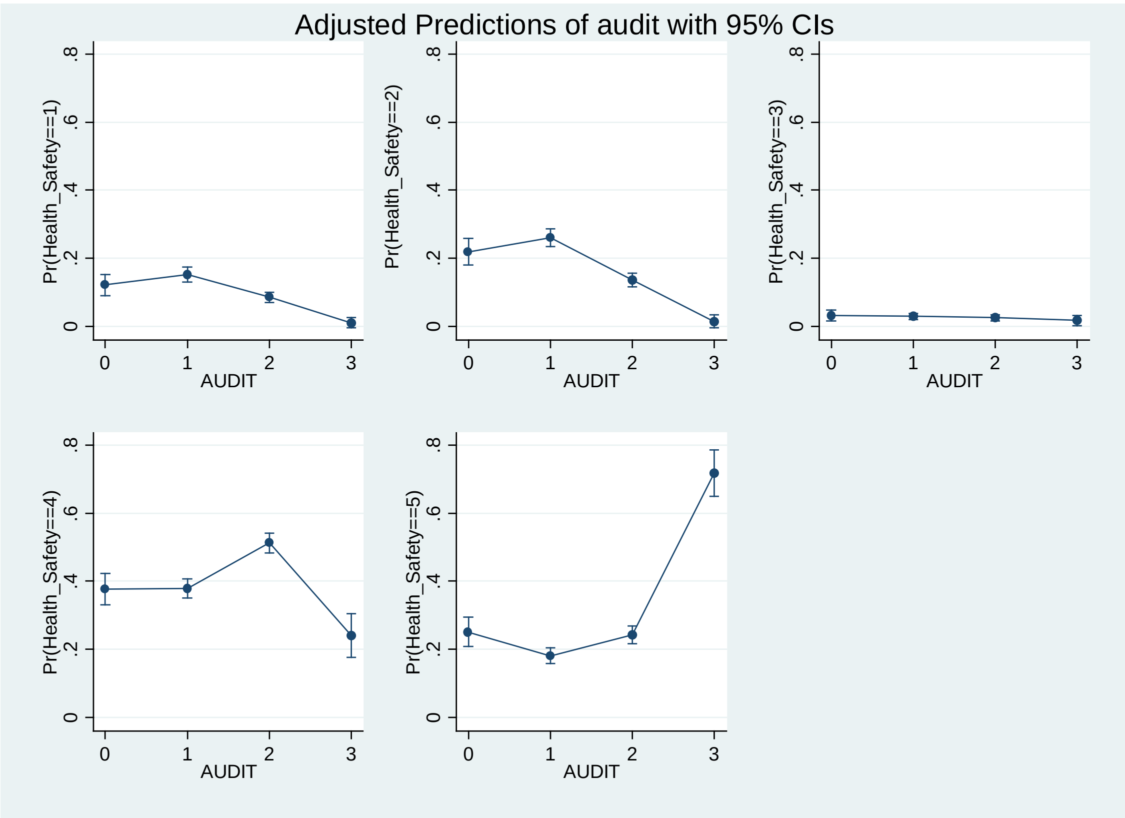
The analysis, therefore, suggests that the level of WCM implementation affects employees' perception on health and safety differently. In particular, perceptions increase with the level of audit, with the only exception of the bronze phase. Moreover, it also shows that perceptions of the sample are generally more positive than negative.

These two information are reported in graph 3.3.1. The graph shows the predicted probabilities for each category of answer of the dependent variable and how they varies with audit.

In general we can observe that the probability of answering categories 1, 2, 3 is lower than for categories 4 or 5, and in some case ("don't know") it is close to zero. Indeed, most of the sample is concentrated in categories 4 and 5.

The probability of answering "strongly disagree" or "disagree" increases when moving from zero to bronze audit, while it steadily decreases for the higher levels of audit. The more the audit rises, the less workers report negative perceptions on health and safety. The probability of answering "don't know" steadily decreases at each level.

Graph 3.3.1: predicted probabilities by audit.



The probability of answering "agree" increases particularly when moving from bronze stage to silver stage. The probability of answering "strongly agree" increases after bronze phase, with a sharp increase between silver and gold phases. These trends shows that positive perceptions ("agree") are concentrated between bronze and silver phase. The most positive ("strongly agree") are concentrated between silver and gold audit. Moving between silver and gold there is always a negative trend of the probability, even for the category "agree". This is due to the fact that in the gold phase almost all employees answered "strongly agree" to the improvement of health and safety.

When we plotted the graphs we found that the predicted probabilities follow different trends for women and younger workers (see next paragraphs).

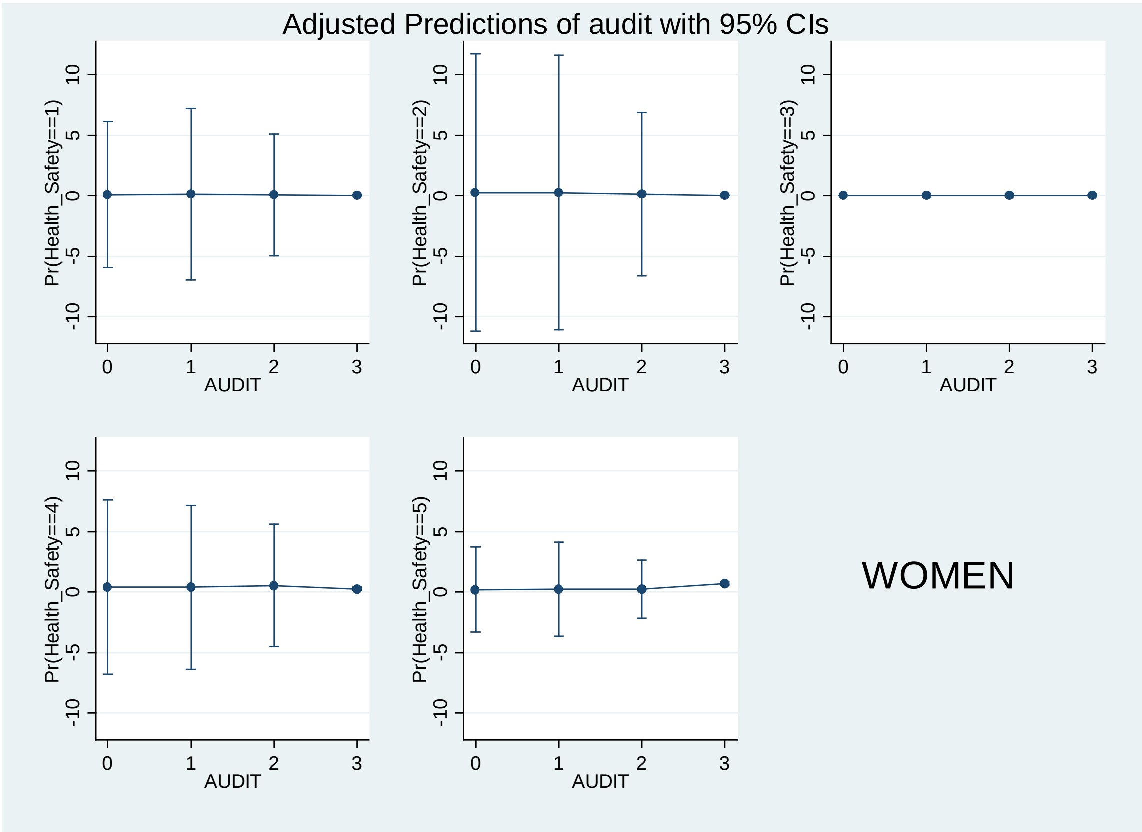
The painting unit perceived less positive improvement with respect to the bodywork, since the log odds of being in another category rather than the baseline decreases everywhere when moving from the bodywork to the painting unit. Conversely, perceptions become more positive (relatively to the baseline) when moving to the assembly unit. With the exception of the category "strongly agree", women have slightly less positive perception of the improvement moving to these two working unit.

For what concern the impact of WCM-related variable, rotation was the variable with the clearest impact on the perception of health and safety. Rotating on more than one station seems to increases the perception of health and safety, since it generally increases the log odds of not answering "strongly disagree". Rotating on more than four station was found to have a negative impact, especially for men and worker older than 36. Perception of health and safety relative to rotation seems to increases more for women and workers younger than 36. Team and feedback were found to be good tools to improve the perception of health and safety only for workers who answered "strongly agree".

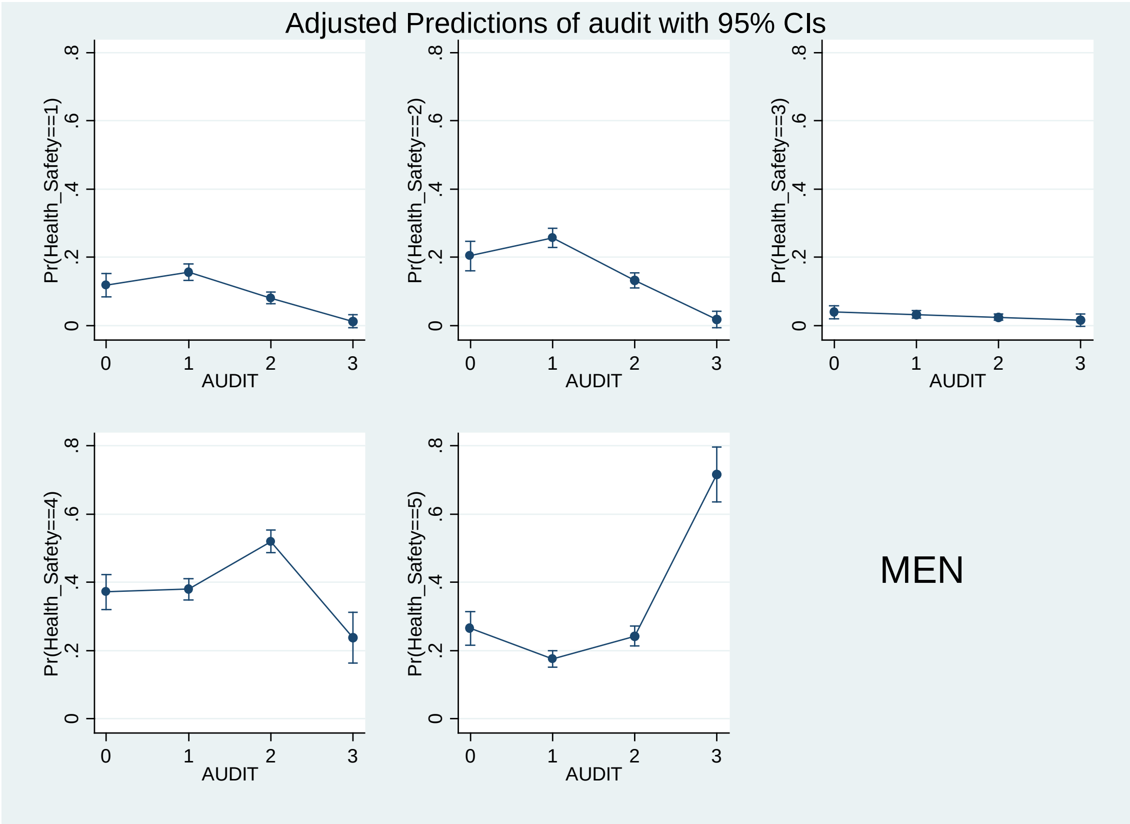
3.3.5.1 Do not women care about WCM?

When analyzing the answers of women and men employees, we found that women are more likely to perceive greater levels of health and safety than men do. In particular, when moving from zero to gold audit, the log odds of being in categories 4 and 5 increases much more for women than for men: respectively by 15.494 and 17.192 for women; by 1.762 and 3.205 for men. This means women have positive perceptions on health and safety at work, as men have. However, no relationship was found between women's perceptions and the level of audit. Graphs 3.3.2 A and B show how the predicted probabilities for each category of answer of the dependent variable differ between women and men.

Graph 3.3.2 A: predicted probabilities by audit for women.



Graph 3.3.2 B: predicted probabilities by audit for men.



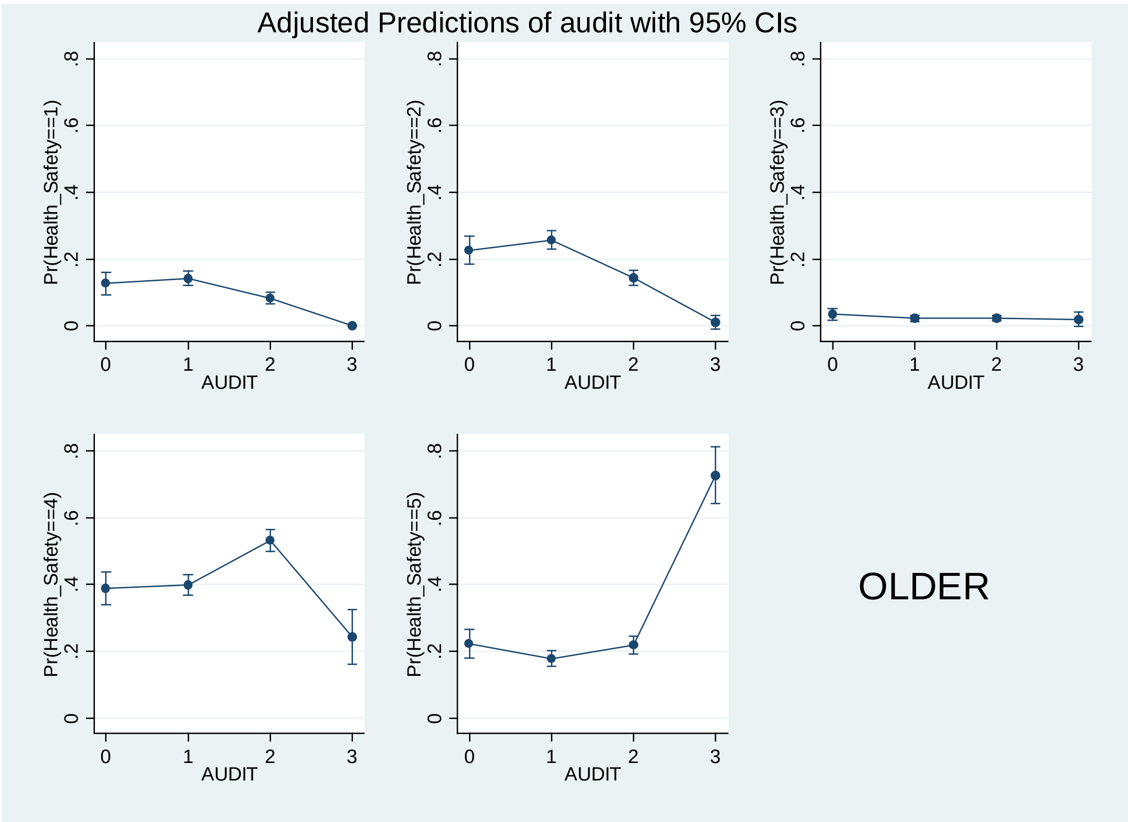
Men report trends in line with those of the entire sample. On the contrary, women show a completely different behavior. The graph shows that the level of audit does not matter for women. Within each category of answer there is no change in the predicted probability by moving to higher level of audit. Being in a different level of audit has no impact on women's perceptions. The analysis, then, suggests that WCM implementation matter more for men than for women for what concern health and safety.

3.3.5.2 Is WCM better for older workers' health?

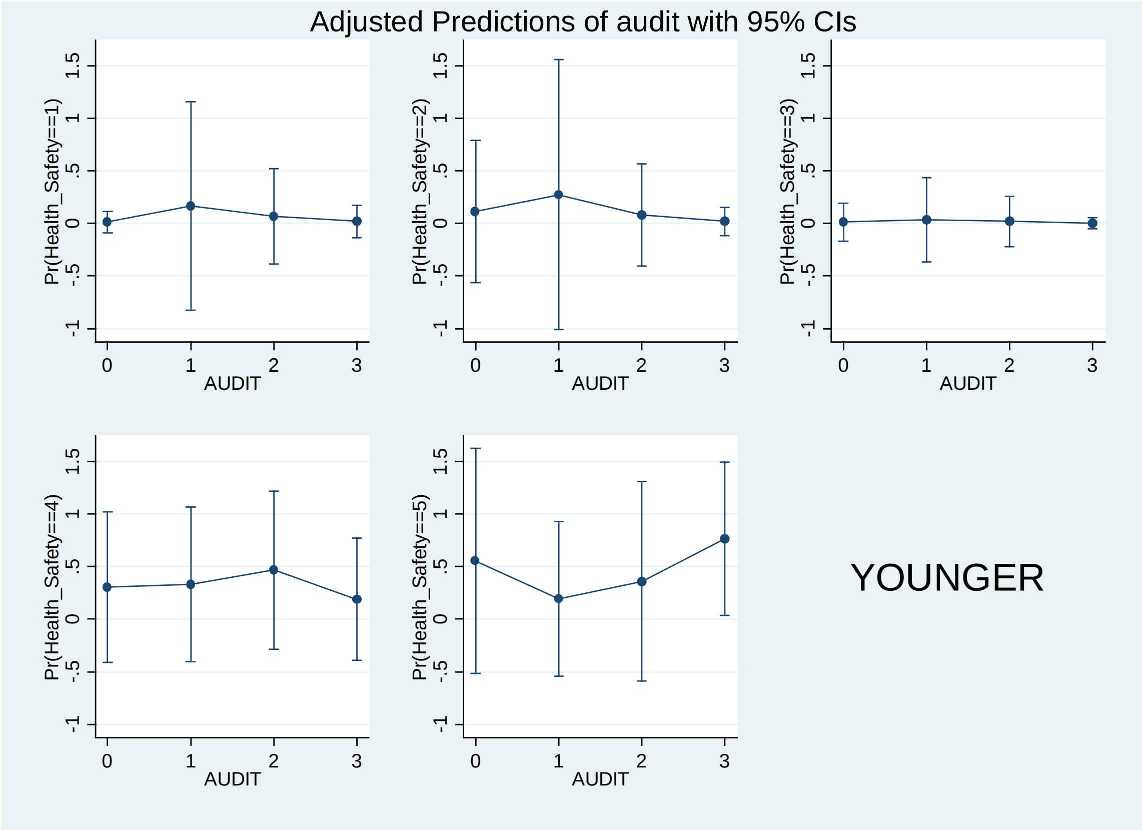
When we analyzed the answers of young and old employees separately, we found that health perception is influenced by age. Younger workers (≤ 36) are less likely to perceive high levels of health and safety than older do. In particular we found that the coefficients of the probability of not answering "strongly disagree" always decrease.

Conversely, for older workers the probability of answering positively rather than strongly negatively to health and safety issue increases most of the time. To this extent, younger workers seem to have more negative perceptions. Moreover, younger workers do not show a significant relationship between the level of audit and the perceived health status. Graphs 3.3.3 A and B show how the predicted probabilities for each category of answer of the dependent variable differ between young and old workers.

Graph 3.3.3 A: predicted probabilities by audit for older than 36 years.



Graph 3.3.3 B: predicted probabilities by audit for younger or equal to 36 years.



We can observe from the graph that the relationship between health and audit that we found for the entire sample is still true for older employees. On the contrary, younger workers' perceptions remain almost unchanged by increasing the level of implementation. Being in a different level of audit has almost no impact on younger employees' perceptions. Indeed, even when they show a slight relationship between audit and perception, however, the probabilities are close to zero. WCM level of implementation, therefore, seems to be more beneficial for older workers.

Conclusions

Issues concerning the reorganization of work prove the need for a comprehensive approach for the transformation process of the manufacturing industry. The adoption of WCM systems means the systematic implementation of various practices in an integrated approach that aims at improving management process and production systems. In the attempt to increase the overall organizational effectiveness, employees' participation become a fundamental asset in the process of change and continuous improvement of a company.

The extent to which WCM impacts on workplace health and safety has been investigated in FCA Italian plants. Qualitative interviews to employees showed that a greater attention is paid on employees' well-being. Trying to reconcile employees' welfare with the improvement of production capacity, activities such as the reduction of accidents, the elimination of ergonomic risks and the promotion of a proactive behavior are continuously carried out and improved.

WCM effects on occupational health and safety have then been investigated through statistical analysis. The results showed an important relationship between the level of WCM implementation and the perceived level of health and safety. It generally increases as the level of WCM reached by the plants increases. However, this relationship is significantly influenced by gender and age.

Younger workers (≤ 36) are less likely to perceive high level of health and safety than older. In addition, the level of WCM implementation seem to matter more for older employees. Indeed, younger workers do not perceive as much benefit as older by increasing the level of audit.

Though most women showed positive perceptions with respect to health and safety, the behavior of their answers reveals an amazing non-correlation with the level of WCM implementation. According to the results, women do not perceive any difference within different level of WCM. They perceive high level of health and safety at work, but they are not related to the level of WCM. The analysis therefore indicates that WCM improvement of health and safety seems to be more appreciated by men; while it seems not to matter for women.

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Appendix

Table 1: Plant observations and level of audit.

Plant	Obs.	Audit
FGA Mirafiori Carrozzeria	163	bronze
FGA Maserati Grugliasco	204	zero
FGA Mirafiori Meccanica	242	silver
FGA Miafiori Presse e Stampi	135	silver
FGA Verrone	159	silver
FGA Cassino	357	silver
FGA Pomigliano	457	gold
FGA Termoli	216	bronze
FPT Foggia	203	bronze
FPT Iveco Torino	311	bronze
Iveco Brescia	125	bronze
Iveco Bolzano	113	zero
Iveco Suzzara	208	silver
CNH Jesi	111	bronze
CNH Lecce	112	silver
CNH S. Mauro	106	zero
MM Corbetta	90	silver
MM Lighting Venaria	86	bronze
MM S. Benigno	49	zero
MM Tolmezzo	53	bronze
Pratola Serra	109	silver
Sata Melfi	526	silver
Sevel V. di Sangro	441	bronze
Teksid Carmagnola	138	zero
Total	4714	

Table 2: results of multinomial regression analysis

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
audit						
1	-.063815	.1839909	-0.35	0.729	-.4244306	.2968005
2	-.1348482	.1976841	-0.68	0.495	-.5223018	.2526054
3	-.2862004	1.047661	-0.27	0.785	-2.339578	1.767177
1.gen	.102347	.1495987	0.68	0.494	-.1908611	.3955551
age	.0171178	.0078057	2.19	0.028	.0018188	.0324167
1.qualifica~n	-.0563498	.1308371	-0.43	0.667	-.3127857	.2000861
unit						
2	-.5014756	.2614273	-1.92	0.055	-1.013864	.0109125
3	.3432745	.172123	1.99	0.046	.0059197	.6806294
4	-1.072269	1.252704	-0.86	0.392	-3.527524	1.382986
5	.2337916	.2184419	1.07	0.284	-.1943467	.66193
rotation						
2	.4063259	.1673257	2.43	0.015	.0783736	.7342782
3	.4482511	.1729329	2.59	0.010	.1093089	.7871933
4	.336643	.265589	1.27	0.205	-.1839019	.8571879
5	-.3517044	.1570547	-2.24	0.025	-.6595259	-.0438829
team						
2	1.092748	.1374411	7.95	0.000	.8233685	1.362128
3	.9765217	.2941901	3.32	0.001	.3999197	1.553124
4	1.08801	.1923585	5.66	0.000	.7109943	1.465026
5	.7294084	.2246071	3.25	0.001	.2891866	1.16963
sugg						
2	.7995205	.1805232	4.43	0.000	.4457015	1.15334
3	-.2710207	.4154474	-0.65	0.514	-1.085283	.5432413
4	.3455173	.1817889	1.90	0.057	-.0107825	.7018171
5	-.0604854	.1826555	-0.33	0.741	-.4184835	.2975127
feedback						
2	.7975725	.1467672	5.43	0.000	.5099142	1.085231
3	.8781281	.3908807	2.25	0.025	.112016	1.64424
4	.7431254	.2292193	3.24	0.001	.2938639	1.192387
5	.8410785	.3222954	2.61	0.009	.2093912	1.472766
_cons	-2.054373	.4511491	-4.55	0.000	-2.938608	-1.170137

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
3						
audit						
1	-.3374217	.3090501	-1.09	0.275	-.9431487	.2683052
2	.0681343	.3225703	0.21	0.833	-.5640918	.7003604
3	1.800515	.9246575	1.95	0.052	-.01178	3.612811
1.gen	.234868	.2585619	0.91	0.364	-.271904	.7416401
age	.0154089	.0137633	1.12	0.263	-.0115666	.0423844
1.qualifica~n	.1973484	.2250858	0.88	0.381	-.2438118	.6385085
unit						
2	-.170588	.4076908	-0.42	0.676	-.9696472	.6284712
3	-.1902742	.2883132	-0.66	0.509	-.7553577	.3748094
4	.8871738	1.048598	0.85	0.398	-1.16804	2.942388
5	.0236708	.3497895	0.07	0.946	-.6619041	.7092457
rotation						
2	-.964164	.3922139	-2.46	0.014	-1.732889	-.195439
3	-.1218376	.3030879	-0.40	0.688	-.7158789	.4722038
4	-.9681097	.6375444	-1.52	0.129	-2.217674	.2814543
5	-.2324308	.24834	-0.94	0.349	-.7191682	.2543066
team						
2	.2518353	.3015679	0.84	0.404	-.339227	.8428976
3	2.57578	.3426796	7.52	0.000	1.90414	3.24742
4	1.074902	.3310591	3.25	0.001	.4260381	1.723766
5	1.225717	.3380974	3.63	0.000	.5630587	1.888376
sugg						
2	-.3665483	.3655437	-1.00	0.316	-1.083001	.3499041
3	.3315828	.5128058	0.65	0.518	-.6734981	1.336664
4	-.409582	.3468846	-1.18	0.238	-1.089463	.2702994
5	-.4585848	.3312281	-1.38	0.166	-1.10778	.1906103
feedback						
2	1.344263	.2842211	4.73	0.000	.7872001	1.901326
3	1.529696	.4953283	3.09	0.002	.5588702	2.500522
4	1.102563	.4080606	2.70	0.007	.3027794	1.902347
5	1.477547	.4538668	3.26	0.001	.587984	2.367109
_cons	-3.007202	.7847283	-3.83	0.000	-4.545241	-1.469163

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
4						
audit						
1	-.2372857	.1778639	-1.33	0.182	-.5858925	.1113212
2	.6495074	.1853104	3.50	0.000	.2863056	1.012709
3	1.999108	.7889827	2.53	0.011	.4527301	3.545486
1.gen	.0506971	.1424156	0.36	0.722	-.2284323	.3298265
age	.0179315	.0074698	2.40	0.016	.0032911	.032572
1.qualifica~n	-.0452503	.1238528	-0.37	0.715	-.2879974	.1974968
unit						
2	-.3688628	.2392707	-1.54	0.123	-.8378247	.1000991
3	.2425142	.1638659	1.48	0.139	-.0786571	.5636856
4	.922819	.7893194	1.17	0.242	-.6242185	2.469857
5	.4365847	.2040471	2.14	0.032	.0366597	.8365097
rotation						
2	.2078058	.1614045	1.29	0.198	-.1085412	.5241528
3	.2877786	.1655943	1.74	0.082	-.0367803	.6123375
4	.1636387	.2571341	0.64	0.525	-.3403348	.6676122
5	-.4520731	.1461602	-3.09	0.002	-.7385418	-.1656044
team						
2	1.213861	.1359441	8.93	0.000	.9474154	1.480307
3	1.29833	.2789142	4.65	0.000	.7516686	1.844992
4	2.097398	.1768392	11.86	0.000	1.750799	2.443996
5	.9606885	.2079247	4.62	0.000	.5531636	1.368213
sugg						
2	.5577235	.174787	3.19	0.001	.2151473	.9002997
3	-.7211242	.3961942	-1.82	0.069	-1.497651	.0554021
4	.237066	.1734868	1.37	0.172	-.1029619	.5770938
5	-.6063966	.1801398	-3.37	0.001	-.9594641	-.253329
feedback						
2	.9497775	.1447395	6.56	0.000	.6660933	1.233462
3	1.193323	.3625283	3.29	0.001	.4827809	1.903866
4	2.186225	.2070897	10.56	0.000	1.780336	2.592113
5	1.639111	.2897201	5.66	0.000	1.07127	2.206952
_cons	-2.116591	.4320834	-4.90	0.000	-2.963459	-1.269723

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
5						
audit						
1	-.5664429	.1990913	-2.85	0.004	-.9566548	-.1762311
2	.316026	.2038695	1.55	0.121	-.0835508	.7156029
3	3.500621	.7843998	4.46	0.000	1.963226	5.038016
1.gen	.1290234	.1626503	0.79	0.428	-.1897653	.447812
age	.0338165	.0086374	3.92	0.000	.0168876	.0507455
1.qualifica~n	.192244	.140276	1.37	0.171	-.0826918	.4671798
unit						
2	-.6041214	.2725115	-2.22	0.027	-1.138234	-.0700087
3	.1290975	.184378	0.70	0.484	-.2322769	.4904718
4	.951469	.8177319	1.16	0.245	-.651256	2.554194
5	.3737549	.2282697	1.64	0.102	-.0736455	.8211553
rotation						
2	.1820063	.1912459	0.95	0.341	-.1928288	.5568415
3	.3995843	.1891828	2.11	0.035	.0287928	.7703759
4	.531696	.2818826	1.89	0.059	-.0207837	1.084176
5	-.1025882	.1644305	-0.62	0.533	-.4248662	.2196898
team						
2	1.295053	.1893004	6.84	0.000	.9240311	1.666075
3	1.861248	.3197608	5.82	0.000	1.234528	2.487968
4	2.331062	.2158409	10.80	0.000	1.908022	2.754103
5	2.519916	.2257569	11.16	0.000	2.07744	2.962391
sugg						
2	.1838175	.2264049	0.81	0.417	-.2599278	.6275629
3	-.7839293	.4627155	-1.69	0.090	-1.690835	.1229763
4	-.2048814	.2223635	-0.92	0.357	-.6407059	.2309432
5	-.2175682	.2175816	-1.00	0.317	-.6440204	.2088839
feedback						
2	.8061512	.1846365	4.37	0.000	.4442703	1.168032
3	1.423956	.405426	3.51	0.000	.629336	2.218577
4	2.32929	.233948	9.96	0.000	1.870761	2.78782
5	2.910922	.2878827	10.11	0.000	2.346683	3.475162
_cons	-3.827294	.5094775	-7.51	0.000	-4.825852	-2.828736

Table 3: results of multinomial regression analysis for women

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
audit						
1	-.1989295	.4514709	-0.44	0.659	-1.083796	.6859372
2	-.5075193	.4489385	-1.13	0.258	-1.387423	.3723841
3	-.3355168	2512.54	-0.00	1.000	-4924.823	4924.152
age	.0013739	.0192464	0.07	0.943	-.0363484	.0390962
1.qualifica~n	-.034848	.3295798	-0.11	0.916	-.6808126	.6111165
unit						
2	-1.131135	.6213887	-1.82	0.069	-2.349035	.0867644
3	.0996228	.45442	0.22	0.826	-.7910239	.9902696
4	-.357627	7301.921	-0.00	1.000	-14311.86	14311.15
5	.682722	.721618	0.95	0.344	-.7316233	2.097067
rotation						
2	1.157254	.403524	2.87	0.004	.3663614	1.948147
3	1.438898	.4555789	3.16	0.002	.5459801	2.331817
4	.7558839	.4952272	1.53	0.127	-.2147436	1.726511
5	.1444692	.3957712	0.37	0.715	-.6312281	.9201666
team						
2	.9754125	.3291826	2.96	0.003	.3302266	1.620598
3	.4622147	.8214132	0.56	0.574	-1.147726	2.072155
4	.8299141	.4318164	1.92	0.055	-.0164305	1.676259
5	2.048303	.6507793	3.15	0.002	.7727985	3.323807
sugg						
2	.2942457	.4073984	0.72	0.470	-.5042404	1.092732
3	-1.809418	1.241429	-1.46	0.145	-4.242574	.6237369
4	.4289764	.4239801	1.01	0.312	-.4020094	1.259962
5	-.1012582	.509176	-0.20	0.842	-1.099225	.8967084
feedback						
2	.3532801	.3564212	0.99	0.322	-.3452927	1.051853
3	1.155955	1.013335	1.14	0.254	-.8301446	3.142055
4	-.1416628	.5547856	-0.26	0.798	-1.229023	.945697
5	.7128156	.89473	0.80	0.426	-1.040823	2.466454
_cons	-1.01011	1.113171	-0.91	0.364	-3.191885	1.171665

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
3						
audit						
1	.5742661	1.247539	0.46	0.645	-1.870865	3.019398
2	1.366707	1.221208	1.12	0.263	-1.026817	3.760231
3	18.40417	1912.493	0.01	0.992	-3730.013	3766.821
age	.0357125	.0356322	1.00	0.316	-.0341253	.1055502
1.qualifica~n	-.5668694	.6695584	-0.85	0.397	-1.87918	.7454409
unit						
2	-.3757049	1.156602	-0.32	0.745	-2.642603	1.891193
3	-.3476698	.8768253	-0.40	0.692	-2.066216	1.370876
4	.8762603	10797.61	0.00	1.000	-21162.05	21163.8
5	-.1346239	1.228151	-0.11	0.913	-2.541756	2.272509
rotation						
2	-.9311164	.9739404	-0.96	0.339	-2.840004	.9777716
3	.4516279	.8148861	0.55	0.579	-1.14552	2.048775
4	-15.8183	1433.328	-0.01	0.991	-2825.089	2793.453
5	.1207418	.6680494	0.18	0.857	-1.188611	1.430095
team						
2	-.5531683	.7797531	-0.71	0.478	-2.081456	.9751196
3	3.125189	.8740251	3.58	0.000	1.412132	4.838247
4	-15.4501	1183.535	-0.01	0.990	-2335.137	2304.237
5	1.668995	.9020363	1.85	0.064	-.0989633	3.436954
sugg						
2	-1.993984	1.039771	-1.92	0.055	-4.031898	.0439302
3	.9288918	1.563757	0.59	0.553	-2.136016	3.9938
4	-.5192619	.849521	-0.61	0.541	-2.184292	1.145769
5	-.7710993	.8716971	-0.88	0.376	-2.479594	.9373957
feedback						
2	1.663516	.7742029	2.15	0.032	.1461063	3.180926
3	.8538263	1.347541	0.63	0.526	-1.787306	3.494959
4	-.6180822	1.444327	-0.43	0.669	-3.448912	2.212748
5	.2833108	1.493964	0.19	0.850	-2.644804	3.211426
_cons	-3.901843	2.260133	-1.73	0.084	-8.331623	.527937

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
4						
audit						
1	-.2895544	.4393078	-0.66	0.510	-1.150582	.5714731
2	.3756519	.4249898	0.88	0.377	-.4573129	1.208617
3	16.17833	1912.492	0.01	0.993	-3732.237	3764.594
age	.016008	.0179677	0.89	0.373	-.0192081	.0512242
1.qualifica~n	.3422835	.3023544	1.13	0.258	-.2503202	.9348873
unit						
2	-.7908302	.5701814	-1.39	0.165	-1.908365	.3267047
3	.2388455	.4442614	0.54	0.591	-.6318909	1.109582
4	17.01616	5502.255	0.00	0.998	-10767.2	10801.24
5	1.183192	.6857829	1.73	0.084	-.1609173	2.527302
rotation						
2	.498925	.3786169	1.32	0.188	-.2431505	1.241001
3	.9476752	.427267	2.22	0.027	.1102473	1.785103
4	.2998395	.4666194	0.64	0.520	-.6147178	1.214397
5	-.1852787	.3596325	-0.52	0.606	-.8901455	.519588
team						
2	1.139517	.3169302	3.60	0.000	.5183454	1.760689
3	1.34379	.7198621	1.87	0.062	-.0671143	2.754693
4	1.647382	.3938069	4.18	0.000	.8755348	2.419229
5	1.380026	.6404607	2.15	0.031	.1247463	2.635306
sugg						
2	.3619996	.4018189	0.90	0.368	-.4255509	1.14955
3	.0263936	1.010287	0.03	0.979	-1.953732	2.00652
4	.5222084	.414763	1.26	0.208	-.2907122	1.335129
5	.2693356	.4649846	0.58	0.562	-.6420174	1.180689
feedback						
2	.6590441	.3418876	1.93	0.054	-.0110433	1.329131
3	.0182821	1.03369	0.02	0.986	-2.007713	2.044277
4	1.643334	.4831102	3.40	0.001	.6964553	2.590212
5	1.107642	.8396363	1.32	0.187	-.5380149	2.753299
_cons	-2.1642	1.062883	-2.04	0.042	-4.247413	-.0809874

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
5						
audit						
1	-.1131885	.514605	-0.22	0.826	-1.121796	.8954187
2	.3432093	.4926786	0.70	0.486	-.6224231	1.308842
3	17.86144	1912.492	0.01	0.993	-3730.554	3766.277
age	.0108368	.0206631	0.52	0.600	-.0296622	.0513358
1.qualifica~n	.2780875	.3456833	0.80	0.421	-.3994394	.9556143
unit						
2	-.3858887	.6599036	-0.58	0.559	-1.679276	.9074986
3	.2545338	.5288199	0.48	0.630	-.7819343	1.291002
4	17.65484	5502.255	0.00	0.997	-10766.57	10801.88
5	1.589919	.7610438	2.09	0.037	.0983009	3.081538
rotation						
2	.5324917	.4478869	1.19	0.234	-.3453505	1.410334
3	.8435351	.4859695	1.74	0.083	-.1089476	1.796018
4	.3896424	.558334	0.70	0.485	-.7046722	1.483957
5	.0244979	.4144008	0.06	0.953	-.7877128	.8367086
team						
2	1.037771	.4388678	2.36	0.018	.1776063	1.897936
3	1.246916	.8338113	1.50	0.135	-.3873237	2.881157
4	2.036712	.483136	4.22	0.000	1.089783	2.983641
5	2.961145	.6729962	4.40	0.000	1.642097	4.280194
sugg						
2	-.2806324	.5428894	-0.52	0.605	-1.344676	.7834112
3	-2.122335	1.330939	-1.59	0.111	-4.730927	.4862569
4	-.0154146	.5326821	-0.03	0.977	-1.059452	1.028623
5	.7619121	.5496655	1.39	0.166	-.3154126	1.839237
feedback						
2	.7242982	.4435495	1.63	0.102	-.1450429	1.593639
3	1.963181	1.087404	1.81	0.071	-.1680915	4.094453
4	1.767595	.5602704	3.15	0.002	.6694847	2.865704
5	2.204019	.8586488	2.57	0.010	.5210981	3.88694
_cons	-3.158171	1.261422	-2.50	0.012	-5.630513	-.6858303

Table 4: results of multinomial regression analysis for men

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
audit						
1	-.0563582	.2061605	-0.27	0.785	-.4604254	.347709
2	-.0646453	.2234989	-0.29	0.772	-.5026951	.3734045
3	-.2413474	1.063361	-0.23	0.820	-2.325496	1.842801
age	.020445	.0086238	2.37	0.018	.0035426	.0373474
1.qualifica~n	-.0246722	.1446056	-0.17	0.865	-.308094	.2587497
unit						
2	-.3643703	.2939827	-1.24	0.215	-.9405658	.2118252
3	.3804868	.1897387	2.01	0.045	.0086057	.7523679
4	-1.036821	1.262299	-0.82	0.411	-3.510883	1.43724
5	.2009778	.2338907	0.86	0.390	-.2574395	.6593951
rotation						
2	.2767458	.1867464	1.48	0.138	-.0892704	.642762
3	.2992576	.1899645	1.58	0.115	-.073066	.6715813
4	.2837207	.3209912	0.88	0.377	-.3454105	.9128519
5	-.4557655	.1729773	-2.63	0.008	-.7947947	-.1167362
team						
2	1.127897	.1529485	7.37	0.000	.8281239	1.427671
3	1.020994	.3185408	3.21	0.001	.3966656	1.645323
4	1.153202	.2176399	5.30	0.000	.7266359	1.579769
5	.5038038	.2482523	2.03	0.042	.0172383	.9903693
sugg						
2	.9179725	.2046054	4.49	0.000	.5169534	1.318992
3	-.1441522	.4516596	-0.32	0.750	-1.029389	.7410843
4	.3161862	.2038897	1.55	0.121	-.0834304	.7158027
5	-.0145688	.1988653	-0.07	0.942	-.4043376	.3752
feedback						
2	.8809417	.1627549	5.41	0.000	.561948	1.199935
3	.8335001	.4284547	1.95	0.052	-.0062556	1.673256
4	.9097788	.2540922	3.58	0.000	.4117672	1.40779
5	.7730658	.3536341	2.19	0.029	.0799557	1.466176
_cons	-2.254657	.4979134	-4.53	0.000	-3.230549	-1.278765
3						
audit						
1	-.4660218	.3275552	-1.42	0.155	-1.108018	.1759745
2	-.103311	.3479462	-0.30	0.767	-.7852729	.578651
3	1.319417	.9843766	1.34	0.180	-.6099255	3.24876
age	.010319	.0151197	0.68	0.495	-.0193151	.0399531
1.qualifica~n	.2959664	.2470125	1.20	0.231	-.1881692	.780102
unit						
2	-.1531933	.455182	-0.34	0.736	-1.045334	.7389471
3	-.1970081	.3146872	-0.63	0.531	-.8137837	.4197675
4	.7789703	1.059396	0.74	0.462	-1.297408	2.855348
5	-.0081887	.3707709	-0.02	0.982	-.7348864	.7185089
rotation						
2	-.9620738	.439945	-2.19	0.029	-1.82435	-.0997974
3	-.1777517	.3377576	-0.53	0.599	-.8397444	.4842409
4	-.6110167	.659031	-0.93	0.354	-1.902694	.6806603
5	-.257009	.2724607	-0.94	0.346	-.7910222	.2770043
team						
2	.452818	.3352425	1.35	0.177	-.2042453	1.109881
3	2.502537	.3869537	6.47	0.000	1.744122	3.260953
4	1.462231	.3595322	4.07	0.000	.7575611	2.166901
5	1.197802	.3766362	3.18	0.001	.4596087	1.935995
sugg						
2	-.1213142	.4043067	-0.30	0.764	-.9137409	.6711124
3	.4918203	.5629969	0.87	0.382	-.6116333	1.595274
4	-.5243077	.3954776	-1.33	0.185	-1.29943	.250814
5	-.4480128	.3695951	-1.21	0.225	-1.172406	.2763803
feedback						
2	1.310749	.3159479	4.15	0.000	.6915026	1.929995
3	1.4435	.5464933	2.64	0.008	.3723925	2.514607
4	1.290243	.4390343	2.94	0.003	.4297512	2.150734
5	1.603502	.4805923	3.34	0.001	.661558	2.545445
_cons	-2.794209	.8580023	-3.26	0.001	-4.475862	-1.112555

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
4						
audit						
1	-.2611323	.1979369	-1.32	0.187	-.6490815	.1268168
2	.7025015	.2082054	3.37	0.001	.2944264	1.110577
3	1.756285	.8163767	2.15	0.031	.1562158	3.356354
age	.0176142	.0083127	2.12	0.034	.0013215	.0339068
1.qualifica~n	-.1080208	.1380885	-0.78	0.434	-.3786693	.1626277
unit						
2	-.2310898	.2701958	-0.86	0.392	-.7606638	.2984841
3	.2652441	.1797667	1.48	0.140	-.0870921	.6175803
4	.7330841	.8072592	0.91	0.364	-.8491149	2.315283
5	.3939701	.2179813	1.81	0.071	-.0332654	.8212056
rotation						
2	.1909632	.1803135	1.06	0.290	-.1624447	.5443711
3	.1987509	.1824784	1.09	0.276	-.1589002	.556402
4	.1359176	.3108564	0.44	0.662	-.4733498	.745185
5	-.4850615	.1612486	-3.01	0.003	-.801103	-.1690201
team						
2	1.242881	.1523853	8.16	0.000	.9442116	1.541551
3	1.237143	.3058147	4.05	0.000	.6377572	1.836529
4	2.215231	.2007797	11.03	0.000	1.82171	2.608752
5	.9488909	.2242213	4.23	0.000	.5094253	1.388357
sugg						
2	.5862323	.1969176	2.98	0.003	.200281	.9721837
3	-.8348561	.4355617	-1.92	0.055	-1.688541	.0188291
4	.1327674	.193445	0.69	0.493	-.2463778	.5119126
5	-.787292	.1983908	-3.97	0.000	-1.176131	-.3984533
feedback						
2	1.029692	.1617465	6.37	0.000	.7126744	1.346709
3	1.317644	.3954012	3.33	0.001	.542672	2.092616
4	2.299851	.2315828	9.93	0.000	1.845957	2.753745
5	1.729476	.3116558	5.55	0.000	1.118642	2.34031
_cons	-2.07152	.477499	-4.34	0.000	-3.0074	-1.135639

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
5						
audit						
1	-.6997183	.2194975	-3.19	0.001	-1.129925	-.2695111
2	.2854246	.2269016	1.26	0.208	-.1592945	.7301436
3	3.208513	.8083596	3.97	0.000	1.624157	4.792868
age	.0386452	.0096382	4.01	0.000	.0197546	.0575358
1.qualifica~n	.2002203	.1559451	1.28	0.199	-.1054265	.505867
unit						
2	-.6675978	.310604	-2.15	0.032	-1.27637	-.0588251
3	.1594107	.2008916	0.79	0.427	-.2343297	.553151
4	.6115789	.8402325	0.73	0.467	-1.035246	2.258404
5	.2541988	.2438928	1.04	0.297	-.2238223	.7322199
rotation						
2	.1508136	.2137435	0.71	0.480	-.268116	.5697431
3	.3419225	.2087106	1.64	0.101	-.0671428	.7509878
4	.6125104	.3336085	1.84	0.066	-.0413502	1.266371
5	-.1101792	.1809058	-0.61	0.542	-.464748	.2443896
team						
2	1.380591	.2127919	6.49	0.000	.9635263	1.797655
3	1.939682	.3501547	5.54	0.000	1.253392	2.625973
4	2.442237	.2448052	9.98	0.000	1.962427	2.922046
5	2.558295	.2463979	10.38	0.000	2.075364	3.041226
sugg						
2	.3120223	.2524087	1.24	0.216	-.1826896	.8067342
3	-.5991464	.5034381	-1.19	0.234	-1.585867	.3875742
4	-.2662616	.2479918	-1.07	0.283	-.7523166	.2197934
5	-.3965373	.2412629	-1.64	0.100	-.8694038	.0763293
feedback						
2	.808199	.2056729	3.93	0.000	.4050876	1.21131
3	1.345677	.4426141	3.04	0.002	.478169	2.213184
4	2.442	.2605004	9.37	0.000	1.931429	2.952572
5	3.023711	.3096571	9.76	0.000	2.416794	3.630627
_cons	-3.997713	.5648606	-7.08	0.000	-5.10482	-2.890607

Table 5: results of multinomial regression analysis for workers ≤ 36

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
audit						
1	-1.606264	.8740929	-1.84	0.066	-3.319455	.1069265
2	-1.928881	.8878149	-2.17	0.030	-3.668966	-.1887955
3	-2.18578	1.622473	-1.35	0.178	-5.36577	.9942095
1.gen	.7427853	.3584945	2.07	0.038	.0401489	1.445422
1.qualifica~n	-.1457506	.2925714	-0.50	0.618	-.71918	.4276788
unit						
2	-2.1177	.9041432	-2.34	0.019	-3.889788	-.3456116
3	.6064903	.5088221	1.19	0.233	-.3907826	1.603763
4	-1.902296	1992.212	-0.00	0.999	-3906.565	3902.761
5	-.3796386	.6427914	-0.59	0.555	-1.639487	.8802093
rotation						
2	-.0007262	.4681337	-0.00	0.999	-.9182514	.9167989
3	.6212216	.4381462	1.42	0.156	-.2375292	1.479972
4	-.1298959	.6693546	-0.19	0.846	-1.441807	1.182015
5	-.084185	.3689923	-0.23	0.820	-.8073966	.6390266
team						
2	1.089678	.3441695	3.17	0.002	.4151177	1.764238
3	1.791747	.8271478	2.17	0.030	.1705669	3.412927
4	1.115568	.4558553	2.45	0.014	.2221078	2.009028
5	1.166991	.6030397	1.94	0.053	-.0149449	2.348927
sugg						
2	.9620537	.5068058	1.90	0.058	-.0312675	1.955375
3	-.518883	1.185868	-0.44	0.662	-2.843142	1.805376
4	.9946564	.4716782	2.11	0.035	.0701842	1.919129
5	.5757591	.4987519	1.15	0.248	-.4017766	1.553295
feedback						
2	.9212789	.3859753	2.39	0.017	.1647812	1.677777
3	.7899868	.9696098	0.81	0.415	-1.110413	2.690387
4	.1437114	.4949426	0.29	0.772	-.8263582	1.113781
5	1.480892	.9268568	1.60	0.110	-.3357141	3.297498
_cons	-.427633	1.023123	-0.42	0.676	-2.432916	1.57765

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
3						
audit						
1	-1.646861	1.459094	-1.13	0.259	-4.506633	1.21291
2	-1.303751	1.459593	-0.89	0.372	-4.164501	1.556999
3	-1.603633	1.995054	-0.80	0.422	-5.513867	2.3066
1.gen	.2079629	.6277172	0.33	0.740	-1.02234	1.438266
1.qualifica~n	.2181213	.5165632	0.42	0.673	-.7943239	1.230567
unit						
2	-.4011357	.9553298	-0.42	0.675	-2.273548	1.471276
3	-.6313348	.7134688	-0.88	0.376	-2.029708	.7670384
4	-1.737176	3103.034	-0.00	1.000	-6083.572	6080.097
5	-2.418359	1.130602	-2.14	0.032	-4.634299	-.2024187
rotation						
2	-1.436108	1.264943	-1.14	0.256	-3.91535	1.043134
3	.4741401	.8558499	0.55	0.580	-1.203295	2.151575
4	-.5818932	1.338758	-0.43	0.664	-3.205811	2.042024
5	1.607978	.6196674	2.59	0.009	.3934524	2.822504
team						
2	.7927231	.6558814	1.21	0.227	-.4927809	2.078227
3	3.83225	.9872615	3.88	0.000	1.897253	5.767247
4	.0912959	.8614478	0.11	0.916	-1.597111	1.779703
5	1.16934	.9313863	1.26	0.209	-.6561436	2.994824
sugg						
2	-1.496424	1.065102	-1.40	0.160	-3.583984	.5911375
3	1.448096	1.473426	0.98	0.326	-1.439767	4.335958
4	-1.499133	1.016732	-1.47	0.140	-3.491891	.4936256
5	-1.321696	1.022195	-1.29	0.196	-3.325161	.6817687
feedback						
2	3.055771	.8768142	3.49	0.000	1.337247	4.774295
3	2.369534	1.406574	1.68	0.092	-.3873006	5.126369
4	2.316759	.9991341	2.32	0.020	.3584917	4.275026
5	3.940797	1.292909	3.05	0.002	1.406743	6.474851
_cons	-1.584014	1.730868	-0.92	0.360	-4.976452	1.808424

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
4						
audit						
1	-2.39517	.8421883	-2.84	0.004	-4.045828	-.7445108
2	-1.184274	.8416233	-1.41	0.159	-2.833826	.4652769
3	-.8578203	1.301625	-0.66	0.510	-3.408959	1.693318
1.gen	.0804882	.36625	0.22	0.826	-.6373486	.798325
1.qualifica~n	-.2753721	.288166	-0.96	0.339	-.840167	.2894228
unit						
2	-.7211079	.6250753	-1.15	0.249	-1.946233	.5040171
3	.1081708	.4893734	0.22	0.825	-.8509835	1.067325
4	12.2079	1465.764	0.01	0.993	-2860.636	2885.052
5	-.8317088	.6026083	-1.38	0.168	-2.012799	.3493817
rotation						
2	.5029352	.4438629	1.13	0.257	-.3670202	1.372891
3	.7053069	.4288776	1.64	0.100	-.1352778	1.545892
4	.4309809	.6291674	0.69	0.493	-.8021645	1.664126
5	-.2964785	.3739556	-0.79	0.428	-1.029418	.4364609
team						
2	.8850801	.3682595	2.40	0.016	.1633047	1.606855
3	2.411016	.8090071	2.98	0.003	.8253914	3.996641
4	1.744453	.4335365	4.02	0.000	.8947371	2.594169
5	1.743054	.5608492	3.11	0.002	.6438103	2.842299
sugg						
2	.8064599	.5611674	1.44	0.151	-.2934081	1.906328
3	.6860837	1.106712	0.62	0.535	-1.483032	2.855199
4	.9707124	.5285398	1.84	0.066	-.0652067	2.006631
5	-.0881927	.5701452	-0.15	0.877	-1.205657	1.029271
feedback						
2	1.668375	.3948608	4.23	0.000	.8944619	2.442288
3	-.1895239	1.011518	-0.19	0.851	-2.172063	1.793015
4	1.988658	.4574705	4.35	0.000	1.092033	2.885284
5	2.337105	.8694229	2.69	0.007	.6330679	4.041143
_cons	-.1118838	.9900679	-0.11	0.910	-2.052381	1.828614

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
5						
audit						
1	-3.533379	.8767618	-4.03	0.000	-5.2518	-1.814957
2	-2.046288	.8681021	-2.36	0.018	-3.747737	-.3448392
3	-.0537249	1.304494	-0.04	0.967	-2.610486	2.503036
1.gen	.4286775	.4050372	1.06	0.290	-.3651808	1.222536
1.qualifica~n	.6024103	.3372054	1.79	0.074	-.0585002	1.263321
unit						
2	-.9939461	.6816531	-1.46	0.145	-2.329962	.3420694
3	-.2340457	.530283	-0.44	0.659	-1.273381	.8052899
4	-1.919368	1702.685	-0.00	0.999	-3339.121	3335.282
5	-1.603116	.6707894	-2.39	0.017	-2.917839	-.2883932
rotation						
2	.0756326	.532709	0.14	0.887	-.9684578	1.119723
3	.6671472	.4803885	1.39	0.165	-.2743968	1.608691
4	.2111257	.697648	0.30	0.762	-1.156239	1.578491
5	.2003027	.4196566	0.48	0.633	-.622209	1.022814
team						
2	2.019718	.5898892	3.42	0.001	.8635567	3.17588
3	3.254115	.9697354	3.36	0.001	1.353469	5.154762
4	2.342964	.6335318	3.70	0.000	1.101264	3.584663
5	3.857725	.700213	5.51	0.000	2.485333	5.230117
sugg						
2	-1.316211	.6755438	-1.95	0.051	-2.640252	.0078305
3	-.0258023	1.317652	-0.02	0.984	-2.608353	2.556749
4	-1.355914	.6325957	-2.14	0.032	-2.595779	-.116049
5	-1.366717	.66438	-2.06	0.040	-2.668878	-.0645561
feedback						
2	2.142234	.5314379	4.03	0.000	1.100635	3.183833
3	-.1432983	1.251536	-0.11	0.909	-2.596264	2.309667
4	2.42336	.5750559	4.21	0.000	1.296271	3.550449
5	4.562788	.8969657	5.09	0.000	2.804767	6.320808
_cons	.010941	1.064209	0.01	0.992	-2.07487	2.096752

Table 6: results of multinomial regression analysis for workers > 36

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1	(base outcome)					
2						
audit						
1	.0086301	.1930634	0.04	0.964	-.3697673	.3870275
2	-.0347873	.2079567	-0.17	0.867	-.442375	.3728004
3	11.42555	408.8624	0.03	0.978	-789.9301	812.7812
1.gen	-.0702388	.1672115	-0.42	0.674	-.3979674	.2574898
1.qualifica~n	-.0798377	.1454232	-0.55	0.583	-.364862	.2051866
unit						
2	-.2943415	.2823575	-1.04	0.297	-.8477521	.2590692
3	.269681	.1850214	1.46	0.145	-.0929543	.6323163
4	-1.06003	1.254678	-0.84	0.398	-3.519153	1.399093
5	.3382935	.2378324	1.42	0.155	-.1278494	.8044364
rotation						
2	.4198187	.1810989	2.32	0.020	.0648714	.7747661
3	.3880022	.1899031	2.04	0.041	.0157989	.7602056
4	.4167868	.2973777	1.40	0.161	-.1660628	.9996364
5	-.5145985	.1768094	-2.91	0.004	-.8611386	-.1680585
team						
2	1.118986	.1514356	7.39	0.000	.8221773	1.415794
3	.8352332	.3195419	2.61	0.009	.2089427	1.461524
4	1.122831	.2179705	5.15	0.000	.6956168	1.550046
5	.6455059	.2439502	2.65	0.008	.1673723	1.12364
sugg						
2	.7689335	.1952249	3.94	0.000	.3862997	1.151567
3	-.2222084	.449038	-0.49	0.621	-1.102307	.6578899
4	.2310633	.1999106	1.16	0.248	-.1607542	.6228809
5	-.1330409	.1992092	-0.67	0.504	-.5234839	.257402
feedback						
2	.7933792	.1609892	4.93	0.000	.4778462	1.108912
3	.955964	.430886	2.22	0.027	.1114429	1.800485
4	.9015864	.264685	3.41	0.001	.3828134	1.420359
5	.774696	.3467082	2.23	0.025	.0951605	1.454231
_cons	-1.207871	.2471983	-4.89	0.000	-1.692371	-.7233715

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
3						
audit						
1	-.5554771	.3285944	-1.69	0.091	-1.19951	.0885561
2	-.0037194	.3388024	-0.01	0.991	-.6677599	.6603211
3	13.93414	408.8616	0.03	0.973	-787.4199	815.2881
1.gen	.2268099	.2909574	0.78	0.436	-.3434562	.797076
1.qualifica~n	.1697099	.2514816	0.67	0.500	-.323185	.6626047
unit						
2	-.0021151	.4669488	-0.00	0.996	-.9173179	.9130878
3	-.0968875	.3270313	-0.30	0.767	-.7378571	.544082
4	.9959517	1.05975	0.94	0.347	-1.081119	3.073023
5	.4949448	.3845871	1.29	0.198	-.258832	1.248722
rotation						
2	-1.118089	.4361292	-2.56	0.010	-1.972886	-.2632911
3	-.2505804	.3294578	-0.76	0.447	-.8963058	.395145
4	-1.207799	.7699199	-1.57	0.117	-2.716814	.3012165
5	-.7390352	.2949866	-2.51	0.012	-1.317198	-.1608721
team						
2	-.0173064	.3645672	-0.05	0.962	-.7318449	.6972322
3	2.532568	.3744286	6.76	0.000	1.798701	3.266434
4	1.306415	.3674152	3.56	0.000	.5862949	2.026536
5	1.304502	.3695497	3.53	0.000	.5801974	2.028806
sugg						
2	-.3105593	.4092583	-0.76	0.448	-1.112691	.4915722
3	.0711122	.577446	0.12	0.902	-1.060661	1.202886
4	-.3151048	.3840134	-0.82	0.412	-1.067757	.4375477
5	-.2807018	.3584613	-0.78	0.434	-.9832731	.4218695
feedback						
2	1.105511	.3163294	3.49	0.000	.485517	1.725505
3	1.469019	.555437	2.64	0.008	.3803821	2.557655
4	.9664413	.4709013	2.05	0.040	.0434918	1.889391
5	1.13794	.4996348	2.28	0.023	.1586737	2.117206
_cons	-2.163602	.4261535	-5.08	0.000	-2.998848	-1.328357

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
4						
audit						
1	-.0908111	.1867802	-0.49	0.627	-.4568935	.2752712
2	.7352553	.1951683	3.77	0.000	.3527324	1.117778
3	14.01201	408.8612	0.03	0.973	-787.3413	815.3653
1.gen	-.006242	.1569347	-0.04	0.968	-.3138282	.3013443
1.qualifica~n	-.0183572	.1367618	-0.13	0.893	-.2864053	.249691
unit						
2	-.2749642	.2648125	-1.04	0.299	-.7939871	.2440587
3	.2075983	.1758719	1.18	0.238	-.1371044	.5523009
4	.7884764	.7964418	0.99	0.322	-.7725208	2.349474
5	.5905014	.2222197	2.66	0.008	.1549588	1.026044
rotation						
2	.1355809	.175198	0.77	0.439	-.2078009	.4789627
3	.1813059	.1819942	1.00	0.319	-.1753961	.5380079
4	.1272727	.2905127	0.44	0.661	-.4421218	.6966672
5	-.5292219	.1612003	-3.28	0.001	-.8451687	-.2132751
team						
2	1.279148	.1482241	8.63	0.000	.9886337	1.569662
3	1.14654	.3019337	3.80	0.000	.5547605	1.738319
4	2.205315	.2002974	11.01	0.000	1.812739	2.59789
5	.8322104	.2259897	3.68	0.000	.3892788	1.275142
sugg						
2	.569718	.1876221	3.04	0.002	.2019855	.9374505
3	-.8294989	.4315942	-1.92	0.055	-1.675408	.0164101
4	.1779554	.1887113	0.94	0.346	-.191912	.5478227
5	-.5901074	.1936254	-3.05	0.002	-.9696063	-.2106086
feedback						
2	.8481334	.157767	5.38	0.000	.5389158	1.157351
3	1.356507	.3985979	3.40	0.001	.5752692	2.137744
4	2.236725	.2402052	9.31	0.000	1.765931	2.707518
5	1.550488	.3099326	5.00	0.000	.9430315	2.157945
_cons	-1.286195	.2383995	-5.40	0.000	-1.75345	-.8189409

health_safety	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
5						
audit						
1	-.3392295	.2097338	-1.62	0.106	-.7503002	.0718411
2	.40381	.2164708	1.87	0.062	-.0204649	.8280849
3	15.66619	408.8612	0.04	0.969	-785.6871	817.0194
1.gen	-.0347912	.1824108	-0.19	0.849	-.3923097	.3227273
1.qualifica~n	-.0097357	.1547934	-0.06	0.950	-.3131252	.2936539
unit						
2	-.6637306	.3098403	-2.14	0.032	-1.271006	-.0564548
3	.109787	.1986102	0.55	0.580	-.2794818	.4990558
4	1.024227	.8186105	1.25	0.211	-.5802196	2.628674
5	.6143573	.2482381	2.47	0.013	.1278197	1.100895
rotation						
2	.1632257	.2069642	0.79	0.430	-.2424166	.5688679
3	.2913894	.208716	1.40	0.163	-.1176864	.7004652
4	.6106164	.3151333	1.94	0.053	-.0070336	1.228266
5	-.2131757	.1820083	-1.17	0.242	-.5699054	.143554
team						
2	1.192672	.2031351	5.87	0.000	.794535	1.59081
3	1.719091	.3420844	5.03	0.000	1.048618	2.389564
4	2.358271	.2382307	9.90	0.000	1.891347	2.825194
5	2.289188	.2421135	9.46	0.000	1.814654	2.763721
sugg						
2	.3586495	.24382	1.47	0.141	-.119229	.836528
3	-.90807	.5045259	-1.80	0.072	-1.896923	.0807825
4	-.0667477	.2423368	-0.28	0.783	-.5417191	.4082237
5	-.0428273	.2341798	-0.18	0.855	-.5018113	.4161567
feedback						
2	.6351359	.2006219	3.17	0.002	.2419241	1.028348
3	1.65076	.4414917	3.74	0.000	.7854526	2.516068
4	2.358407	.2669568	8.83	0.000	1.835181	2.881633
5	2.615146	.3088635	8.47	0.000	2.009785	3.220508
_cons	-2.279386	.293066	-7.78	0.000	-2.853785	-1.704987