AN EXPLORATION OF EFFECTIVE SUPERVISORY ENGAGEMENT IN THE CLOTHING INDUSTRY THROUGH ACTIVITY SAMPLING TECHNIQUE

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ABSTRACT

The gradual decrease in income through national and international competition led around 50% of South African clothing manufacturers to shut down their businesses in the past decade. In the struggle to improve their productivity, organisations are evaluating human assets for further value-add. Industry 4.0 embraces the total interaction of technology and human resources to create a multi-skilled environment. In this endeavour, first-line managers (supervisors) in the clothing manufacturing industry play a critical role in eliminating non-value-added activities. The meteoric rise of technology-driven processes driven by Industry 4.0 has disrupted almost all business models, and the clothing sector is not immune to these winds of change. It lacks the drive to undertake continuous improvement owing to an impasse in the skills-driven improvement and the application of industrial engineering principles. Organisations are seeking improvement opportunities in multi-skilling the workforce. In this study, supervisory activities were evaluated to determine value-add in the production process and to evaluate supervisory engagement to identify non-value-added activities and to lay a foundation for leveraging human capital as a competitive advantage. The research adopted the application of activity sampling analysis through a case study at a clothing manufacturer. Direct observation and informal discussions on the factory floor were used as the primary means of data collection. The outcome of the research points to gaps between the machine age, which was characterised by a command-and-control authority, and the conditions of the digital age, which requires a new role for shop floor coaches, in which the supervisor motivates and leverages the symbiotic relationship between employees and technology in producing goods.

OPSOMMING

Die geleidelike afname in inkomste deur nasionale en internasionale mededinging het daartoe gelei dat ongeveer 50% van Suid Afrikaanse klerevervaardigers hul besighede in die afgelope dekade gesluit het. In die stryd om hul produktiwiteit te verbeter, evalueer organisasies menslike bates vir verdere waardetoevoeging. Industrie 4.0 omhels die totale interaksie van tegnologie en menslike hulpbronne om 'n multi-geskoolde omgewing te skep. In hierdie strewe speel eerstelynbestuurders (toesighouers) in die klerevervaardigingsbedryf 'n kritieke rol in die uitskakeling van aktiwiteite wat nie waarde toevoeg nie. Die meteoriese opkoms van tegnologiegedrewe prosesse wat deur Industrie 4.0 aangedryf word, het byna alle sakemodelle ontwrig, en die kleresektor is nie immuun teen hierdie winde van verandering nie. Dit ontbreek die dryfkrag om deurlopende verbetering te onderneem as gevolg van 'n impasse in die vaardigheidsgedrewe verbetering en die toepassing van bedryfsingenieursbeginsels. Organisasies soek verbeteringsgeleenthede in die multi-vaardighede van die arbeidsmag.

In hierdie studie is toesighoudende aktiwiteite geëvalueer om waardetoevoeging in die produksieproses te bepaal en om toesighoudende betrokkenheid te evalueer om nie-waardetoegevoegde aktiwiteite te identifiseer en om 'n grondslag te lê vir die benutting van menslike kapitaal as 'n mededingende voordeel. Die navorsing het die toepassing van aktiwiteitsteekproefontleding deur 'n gevallestudie by 'n klerevervaardiger aangeneem. Direkte waarneming en informele besprekings op die fabrieksvloer is as die primêre manier van data-insameling gebruik. Die uitkoms van die navorsing dui op gapings tussen die masjien-era, wat gekenmerk is deur 'n bevel-en-beheer-owerheid, en die toestande van die digitale era, wat 'n nuwe rol vir winkelvloerafrigters vereis, waarin die toesighouer motiveer en die simbiotiese verhouding tussen werknemers en tegnologie in die vervaardiging van goedere benut.

1. INTRODUCTION

The South African clothing and textiles industry is a highly diverse and mature industry, with an important role to play as an employer [1]; however, [2] argues that South Africa's clothing industry is in crisis, and has been facing massive job losses over the years [3].

There is a possibility that more jobs may be shed in South Africa (SA) over the next few years. The cut, make, and trim (CMT) industries find it difficult to negotiate wage increases as production costs escalate out of all proportion. If the lay-off of workers continued in the clothing industry, it would increase the unemployment rate, thus impacting the economy.

Morris and Barnes [4] conducted a study to evaluate the clothing industry's employment rate over ten years (2003 to 2013). Their analysis revealed that the number of employees declined from 97 960 in 2003 to 52 656 in 2013 – a 46.25% decrease in the employment rate. The clothing market is dominated by large retailers that outsource a major part of their production to Eastern manufacturers, with supplier network structures that pressurise producers to contain costs [5]. Fashion production with minimal lead times makes demand forecasting and production planning extremely difficult [6]. Quality management, on-time delivery, and cost management are the fundamental components of a successful organisation [7]. In this regard, supervisory activities play a crucial role, not only to ensure financial prosperity but also to ensure that resources are used optimally. The clothing industry is evaluating every asset thoroughly to ensure maximised productivity. Supervision, as part of first-line management, is seldom evaluated for value-add. This lack reinforces the purpose of the study.

This research highlights that the total content of the work done is not homogeneous, but a mixture of productive work and excess non-productive work, because work is commonly not done in the most efficient and effective ways [8]. Therefore, the impact of supervision activities in ensuring a high content of productive work is critical and makes quality supervision indispensable. A supervisor's activities and tasks can be categorised in line with Groover's theory of productive and non-productive work content; and so research, particularly, in this case, can reveal which activities are non-value adding and therefore non-productive.

To highlight the supervisory activities that were relevant to this study and the context of this research, activity sampling was conducted on the shop floor, where real-time production takes place. Supervisors were studied in action, and their activities were analysed as they performed them in operations. Therefore, the activities highlighted in this paper are not a definitive list of supervisors' activities, but rather a list of the activities that were performed during the study of a particular work setting and in a specific work system. This specific work system consisted of tasks that were allocated to labour and tasks consisting of work elements that were performed through basic motion elements.

It was apparent, therefore, that a supervisor's task is to ensure a productive mix of tasks and basic work elements that will lead to a decrease in non-productive work content and a concomitant increase in productive work content. Supervisors ensure the achievement of this goal by performing a great number of tasks and activities, which in the context of this research are reflected in the list below. These activities form part of supervisors' activities in production and are specific to the context and the particular type of work system. Since these activities are what supervisors do when they work, they are critical in the execution of the aim of this research, which was to evaluate supervisory engagement to identify non-value-added activities and lay a foundation for leveraging human capital, and so establish a competitive advantage for the firm in this industry.

Supervision and supervisory competence play a crucial role in maintaining acceptable levels of productivity in clothing manufacturing. Although the primary management activities of planning, organising, leading, and controlling are paramount, the responsibility of the clothing industry supervisor goes beyond this paradigm. Some of the intricate attention to detail is highlighted in the following major areas of competence that a supervisor should possess:

- Communication skills: The ability to communicate effectively at all levels of the organisation with the right attitude and behaviour, being responsible and accountable. Supervisors must keep staff motivated at all times to achieve production targets.
- Product quality: Quality consists of product features that meet the needs of the customer with the correct manufacturing specifications. This includes garment cutting that ensures that all product specifications are considered as the sewing line does not allow for cutting amendments. This includes the prevention of incorrect cuts, misplaced notches, frayed edges, incorrectly marked positions, and the like.
- Machine quality: Ensuring that all of the technical aspects of the machine are correct for every type of garment that is sewn.
- Work-study: Supervisors are required to understand the calculation of standard minute values (SMV) and targets for every operation. In addition, supervisors must perform line balancing to ensure the optimum use of machines and staff.
- Production planning: With frequent style changes and customer deadlines, supervisors are responsible for the planning of production with minimal loss of time in changeovers.
- Motivation: In a labour-intensive industry, supervisors are required to communicate with staff regularly. Labour productivity is influenced by the motivation level of the staff.
- Line balancing: As an important component of work-study, supervisors are required to move staff around the production floor to achieve effective line balance.

2. LITERATURE REVIEW

2.1. Traditional role of supervisors in manufacturing

Supervisors play a critical role in management. According to [9], the supervisor is the one at the bottom of the management pyramid, but they play a key role in managing production operations and other resources that are required to manufacture goods. This view is reinforced by [10], who argues that supervisors play an important role as intermediaries between management and operational employees. [11] argues that first-line supervisors are the first level in an organisation's management hierarchy and are responsible for managing the work of employees. The aspects described by those authors provide insights into the levels of management responsibility that supervisors exercise in their daily duties in a manufacturing context. The conceptual definition of 'a supervisor' requires that research delve deeper into the duties and responsibilities that are vested in supervisors.

In its report, [12] argues that production supervisors should exhibit above-average leadership qualities. Their duties and responsibilities cover a wide spectrum, including the following:

(a) Coordinate the organisation, staffing, and operational activities for assigned maintenance and operations programmes; direct, coordinate, and review the work plan for assigned maintenance and operational services and activities; assign work activities and projects; monitor work-flow; review and evaluate work products, methods, and procedures; and meet with staff to identify and resolve problems.

(b) Supervise staff and participate in performing daily inspections, operations, and equipment maintenance.

(c) Identify opportunities for improving service delivery methods and procedures; identify resource needs; conduct reviews with management staff; implement improvements.

(d) Relate effectively and diplomatically in all areas of employee relations, always projecting a professional image in keeping the organisation's goals and objectives while exercising the highest degree of confidentiality; select, train, motivate, and evaluate assigned personnel; provide or coordinate staff training; work with employees to correct deficiencies; implement discipline and termination procedures.

(e) Participate in interviewing and hiring new staff; assign and review work; counsel employees on performance problems and take or recommend disciplinary action; approve time off for payroll purposes and prepare and sign employee evaluations.

(f) Perform the more technical and complex tasks of the work unit and train others to do the same.

In their study, [13] argue that production functions performed by supervisors can be broken down into various components that together characterise the routine functions of a supervisor. These components are: (a) planning and programming production (b) planning the daily use of resources; (c) doing the preparation to execute plans; (d) routine distribution and transfer of work; (e) inspecting raw materials, products and operational work, and plant; (f) reporting of technical contingencies; (g) dealing with human contingencies; (h) selecting staff; (i) training staff; (j) administering wages; (k) acting as the communication link between the shop floor and management; and (l) writing reports and keeping records.

2.2. Winds of change and the evolving role of the production supervisor

The world is on the brink of crossing into a new digital era [14] that is transforming society and organisations globally. It is an era that is also known as the 'Fourth Industrial Revolution', which is driven by Industry 4.0's disruptive technologies [15]. The term 'Industry 4.0' embraces the concept of smart factories that are underpinned by smart digitally boosted devices that are connected remotely to enable the communication of resources and materials throughout manufacturing value chains. It is characterised by agility, speed, and efficacy [16]. This view is reinforced by [17], who asserts that Industry 4.0 implies the digitisation of manufacturing through connected networks of humans and robots, which interact and work together and promote information-sharing and analysis along the whole global value chain.

The theoretical underpinnings of the advent of the Fourth Industrial Revolution, made visible in the form of Industry 4.0 (I4.0), suggest that the role of the supervisor will evolve as 4IR continues to disrupt business models in every sector, including manufacturing. This reality – that the supervisory role is being changed because of the transformative nature of I4.0 – is alluded to by [9] who argues that supervisory practices evolved significantly in the latter part of the 20th century, mostly influenced by changes in manufacturing technologies and workforce characteristics. Yet today's manufacturing organisations are composed of ever-advancing automated technologies and unique workforce characteristics that call for the further reform of how supervision is done. [18] argues that, historically; supervision has been viewed as a process that is concerned with accomplishing work through other people. However, manufacturing has become highly technology-orientated, and so the impact of technology on productivity and on employees cannot be ignored. The changing role of the supervisor from traditional supervision to modern-day supervision demands that the supervisor be able to understand the concept of technology and to leverage the employee-technology symbiosis that drives modern smart plants [18].

The literature points to a changing business model landscape that is driven by I4.0 technologies, which are disrupting almost every industry, including manufacturing. The literature notes the additional demand on supervisors to become technologically adept with a view to leveraging the employee-technology symbiosis – the cornerstone of modern manufacturing industries, which operate in a world that is volatile, uncertain, complex, and ambiguous. In their report, [19] proposes that work in the 21st century requires four key skill sets: (a) communication skills, including language proficiency and the ability to present ideas; (b) collaborative skills, including the management of group activities and social interactions; (c) individual learning approaches, including critical thinking, metacognition, and new skills acquisition; (d) individual autonomy, including flexibility, adaptability, and entrepreneurship; and (e) ICT and digital literacy, including the use of technology as a tool for learning, communication, and collaboration.

Supervisors therefore need to move from the traditional supervisory role of command and control to become workplace coaches; and this requires a sharpening of the skills of the 21st century, as described by [19], which would enable the 21st-century technologically oriented supervisor to leverage the symbiotic relationship of technology and employee to achieve the business' goals and objectives at the shop-floor level. This requires that engineering management be incorporated into managing complex manufacturing value chains that are emerging globally as companies become interconnected within borders and beyond, and as globalisation and digitalisation become dominant.

The engineering management body of knowledge, as described by [20] and reinforced by [21], points to eleven domains: an introduction to engineering management; leadership and organisational management; strategic planning; financial resource management; project management; operations and supply chain management; marketing and sales management in an engineering organisation; the management of technology, research, and development; systems engineering; legal issues in engineering management; and professional codes of conduct and ethics.

3. RESEARCH METHODOLOGY

Research is the process of collecting, analysing, and interpreting information to respond articulately to questions that have been posed or to a phenomenon being studied [22]. This view is reinforced by [23], who suggest that research is a logical and systematic search for new and useful information on a specific phenomenon. Inductive reasoning begins not with a pre-established truth or assumption, but instead with observation; while deductive logic begins with one or more premises [24]. This paper adopted an inductive approach that focused on the observation of supervisors; the research also chose to use a qualitative research methodology, as it is exploratory in nature rather than explanatory, and a case study as its research strategy. Yin [25] defines the case study research method "as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used". The case study, which took the form of a pilot study, was conducted at XYZ Textiles. The case study method was adopted to investigate a modern-day phenomenon in its real-life context – the shop floor – which was driven by a range of dynamics that could either inhibit or enable its efficiency.

The study was grounded in the collection of data through random observations of the identified supervisors. This was used to determine the types of supervisor activity that were at play on the shop floor. The activity sampling technique was adopted as a data collection tool, and the results were obtained from observation of the seven supervisors; the data was interpreted to determine the supervisor activities that were at play on the shop floor.

3.1. Sampling

Purposive sampling was adopted for this study. Purposive or judgmental sampling is an approach in which particular settings persons or events are intentionally selected in order to provide vital information that cannot be attained from other choices [26]; [27]. Seven supervisors were purposively chosen for their skills, experience, and diligence. The supervisors were labelled supervisor A to supervisor G.

4. FINDINGS AND DISCUSSION

Data analysis of the supervisors' activities in the production environment

4.1.1. Percentage prevalence distribution

Figure 1 depicts the supervisors' activities, and the results paint a worrying picture of poor leadership visibility on the shop floor. It could be highlighted that the supervisors spend at least 19% of their time away from the shop floor, where their core responsibilities are located. When the 19% absence from the shop floor is combined with 8% in idle time, this comes to 27% of non-value-adding activities, which is just above a quarter of all the available time for a supervisor in a particular shift. In the 21st century, when volatility, uncertainty, complexity, and ambiguity drive the world, supervisors should be agile in managing the shop floor, and play the role of coach to shop-floor employees. In the context of the engineering management body of knowledge, which was designed to address the skills of the 21st century that each leader should possess, it is clear that there are gaps between the machine age (which was characterised by mass production and a command and control approach to supervision and management) and the digital era, which is driven by I4.0, in which supervisors act as shop-floor coaches and are expected to leverage the symbiotic employee-technology relationship in order to make the shop floor smart, efficient, agile, and effective.

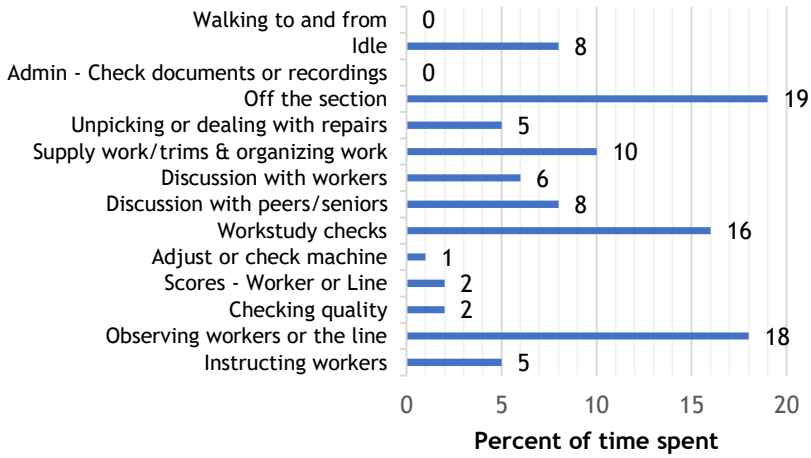

Figure 1: Time allocation per supervisor activity

4.1.2. A common point on the OC curves for a family of sampling plans that meet the AOQL at 100p0 stipulation.

The industrial sample used in this research showed the common point on the AOQ curve to be around 79% (Figure 2), which is the point at which supervisory activities have a greater impact on productivity. Therefore, from the sampling used, the supervisory activities that are likely to impact positively on the production line are those with a high focus percentage.

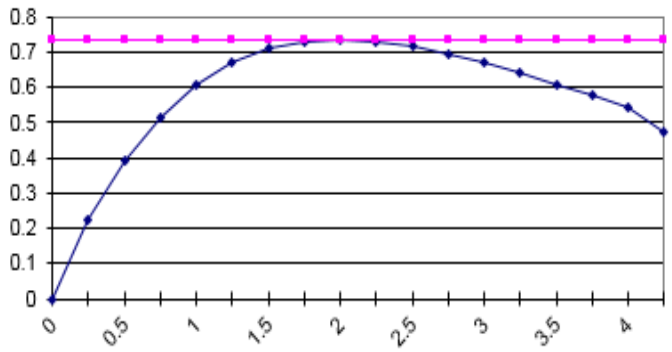

Figure 2: AOQ curve

4.1.3. Cumulative % graphs

The cumulative comparison chart (Figure 3 below) shows that the frequency of a supervisor's activity has a positive impact on productivity improvement. For example, the following activities highlight the significance of the frequency of occurrence. When the activity of observing the worker or the line (occurrence = 18.8%, rounded to 20%) is compared with unpicking or dealing with repairs (occurrence = 1.9%, rounded to 2%), it is apparent that observing the worker or the line would have a greater impact on improving the productivity of the line.

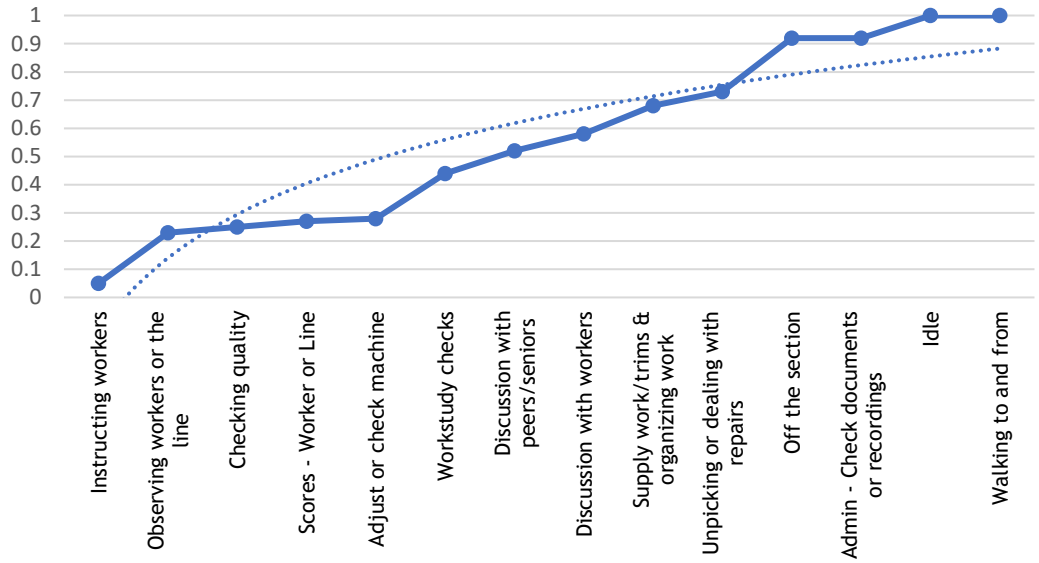

Figure 3: Cumulative charts

4.1.4. Histograms

The histogram and cumulative percentage charts depicted in Figures 4 and 5 reveal the frequency distribution of the supervisor activity in the particular production line.

The first three activities have a high frequency, and there is probably a high impact on the production line. The percentage of each of the three activities, when compared with the percentage of occurrence in the cumulative percentage chart, indicates a high impact on the production line – for example, the bin of observing workers is equal to the percentage occurrence of the activity.

The graph is skewed to the left, which is an indication that the prevalence of supervisor activity was not normally distributed, and therefore that not all activities would have a positive impact on the productivity of the production line. Some activities would have the desired impact on the line if their prevalence were high. This supports the Pareto analysis theory, and calls for an increase in the supervisor activities that form part of the few vital activities.

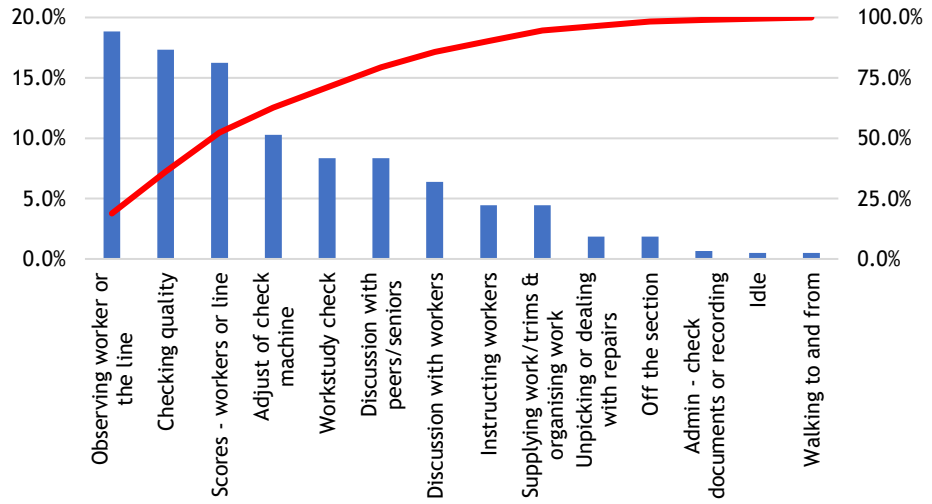

Figure 4: Histogram chart

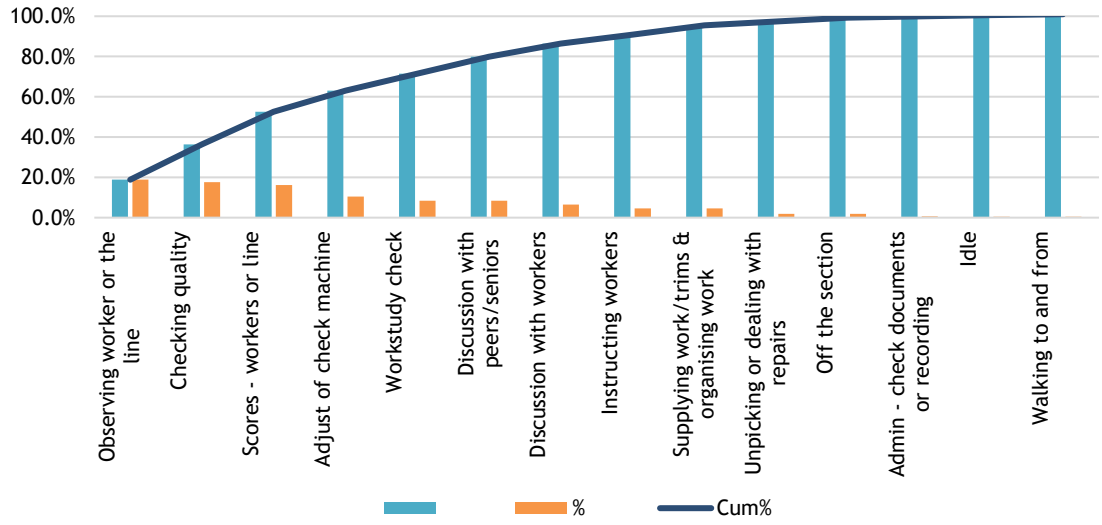

Figure 5: Cumulative charts

4.1.5. Vital few and important many

Based on the Pareto principle, 20% of the supervisors' activity will result in 80% of production output, and 80% of the rest of the activities will yield 20% output. The activities seen in the activity prevalence chart below are those on the 0.8 line – that is, discussion with peers; work study; checking machine; scores – workers; checking quality; and observing workers.

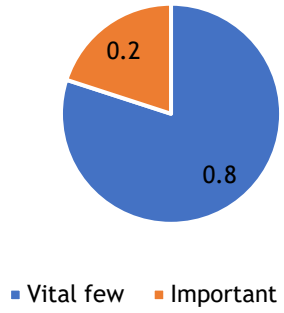

Figure 6: Vital few and important many

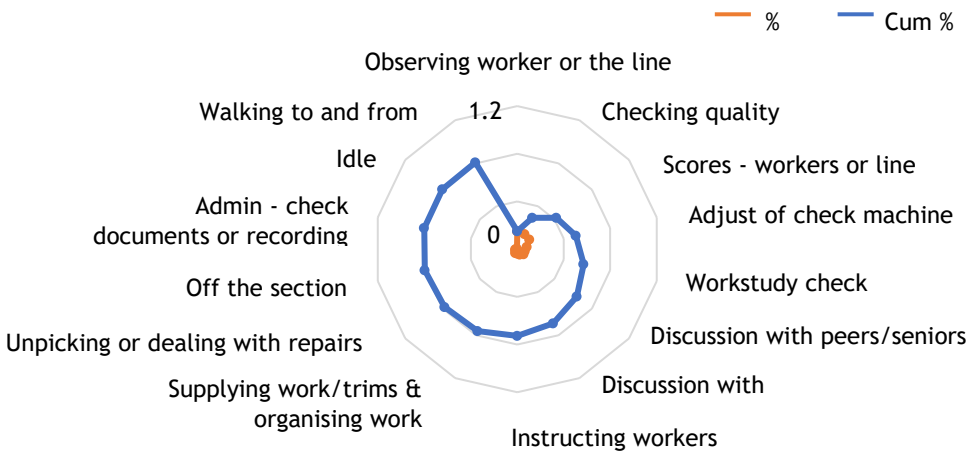

Figure 7: Activity prevalence chart

4.1.6. Pareto chart

The Pareto graph below depicts the diminishing impact of the supervisors' activities on the production line. This diminishing impact is a result of the percentage of the prevalence of the activity.

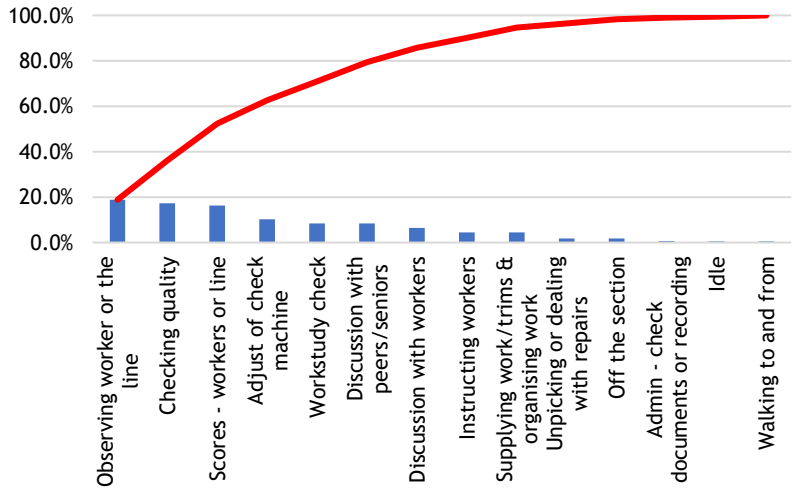

Figure 8: Pareto chart

4.1.7. Hypothesis testing

(a) H_0: $\mu = 5.7$
H_a: $\mu \neq 5.7$

(b) Level of significance $\alpha = 0.05$
(c) Mean = 6.1 minutes
(d) Standard deviation = 2.3
(e) Test statistics

$Z = \bar{x} - \mu / (\sigma / \sqrt{n})$

$Z = 6.1 - 5.7 (2.3/\sqrt{36})$

$Z = 1.04$

$\alpha/2 = 0.05/2 = 0.025$

The Z-value computed does not fall in either of the two tails of the critical regions (-1.96 <Z >1.96). Therefore, Ho is not accepted, and it is concluded, with a 5% margin of error, that when supervisor activities that form part of the Pareto are increased in the daily execution of supervision, productivity will increase.

4.1.8. Regression analysis

Figure 9 illustrates a linear correlation between the supervisors' activities and the weight of the activities as a result of supervision. The R2 standing at 0.999 is very close to 1, demonstrating a positive correlation.

Table 1: Supervisor activities and weight of activities

Total number of times the activity is performed (X)	The weight of the activity as part of the supervision (Y)	X2	XY
20	4	400	80
84	17	7 056	1 428
6	1	36	6
15	3	225	45
10	2	100	20
92	19	8 464	1 748
49	10	2 401	490
48	10	2 304	480
38	8	1 444	308
9	2	81	18
64	13	4 096	832
12	2	144	24
16	3	256	48
20	4	400	80
483	100	2 332 89	48 300

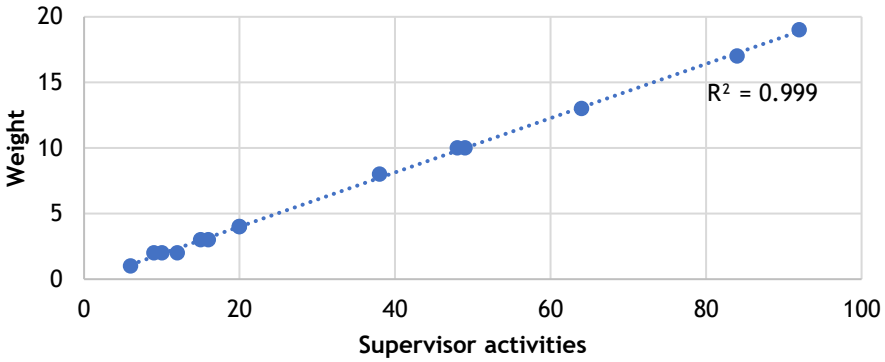

Figure 9: Regression analysis graph

5. CONCLUSION AND RECOMMENDATIONS

The aim of this research was to evaluate supervisor activities and understand how supervisors spent their time on the shop floor. A comprehensive literature review was presented that examined the supervisor attributes, duties, and responsibilities that were typical in the machine age, which could best be described as an era of mass production. The literature review also investigated the digital age that has been ushered in by the Fourth Industrial Revolution (4IR) and is experienced as the Industry 4.0 (I4.0) disruptive technologies that drive the digital revolution. The evolving role of the supervisor in the digital age of smart factories was explored and presented. The engineering management body of knowledge (EMBK) was explored and presented together with the 21st century skills that are required for all leaders, including supervisors as front-line leaders on the shop floor.

The results showed that there is a leadership vacuum because supervisors are absent from their core business. This was presented in the results in Figure 2, which depicted the tasks in which supervisors engaged, and their contribution to the total available time. The results pointed to a 27% non-value-adding time, which consisted of supervisors not being on the shop floor (19% and supervisors standing idle (8%). This highlighted a gap between the traditional role of a supervisor as a command-and-control authority and the 21st century role, in which supervisors are expected to become shop-floor coached who motivate employees and leverage the symbiotic technology-employee relationship in the quest to produce products effectively, efficiently, and with the necessary agility and speed.

With specific reference to the case study, the role of the supervisor is critical in the clothing production process. The supervisor ensures the elimination of non-value-added activities through frequent patrols of the production line. The supervisor also ensures the effective planning of incoming work, including the trims, thread, needles, and any other items that the line needs. The next important activity is organising the people and the machines by examining difficult operations on garments. Leading operators through effective communication about their tasks is important in ensuring line effectiveness and efficiency; and control through the monitoring of standards on operations and output is paramount in clothing assembly and production. However, these responsibilities fall short of what the supervisor in the 21st century ought to be involved in; the current role is still rooted in the machine-age paradigm of lead-and-control, typified by the command-and-control philosophy. This limitation will adversely affect the competitiveness of any manufacturing industry that has not yet moved from the machine age into the digital era, in which smart manufacturing reduces costs and waste, and improves efficiency, effectiveness, quality, safety, agility, and throughput. The supervisor, as the person at the coalface of first-line leaders, should be equipped with the tools to navigate the ever-changing technological landscape, and to motivate employees as a shop-floor coach who is capable and can leverage the symbiotic employee-technology relationship.

The engineering management body of knowledge should be a toolbox with which every production supervisor is equipped, as it can equip them with the 21st century skills that were identified in this research. Critical thinking skills, collaboration skills, communication skills, leadership skills, and digital skills are the non-negotiable tools that each leader must possess if they are to succeed in the digital age.

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