CHAPTER 1: Introduction

1.1 Background

The Expanded Public Works Programme (EPWP) in South Africa is an on-going government initiative aimed at generating a million temporary employment opportunities for the currently unemployed by the year 2009 within four sectors; namely the infrastructure, economic, social and environment sectors. The programme aims to generate seven hundred and fifty thousand (750,000) of these employment opportunities within the infrastructure sector.[1] The infrastructure work covers four main categories within the civil construction industry. These categories are namely low-volume roads, trenching, storm water, and sidewalks. Task rates have been prescribed for the activities involved in the construction of these categories of projects. In order to promote the sustainability of emerging/small contractors, the EPWP has established a contractor learnership programme which provides managerial and technical skills amongst others to emerging contractors through classroom and on-the-job (project) training.[2]

It is the intention of the EPWP to expand into other construction related operations such as building work. The building industry has been traditionally labour-intensive. However, several authorities have noted that skills and productivities in the industry are lower than those achieved fifty years ago, which means that building is now **labour-extensive**. It is generally accepted that managerial inefficiencies and the lack of adequate formal training for apprentices have contributed to the low productivities. The building industry in South Africa prescribes productivity norms for building activities rather than task rates.[3] The EPWP is currently considering a framework that will enable it to set task rates for building activities. The past and present state of artisanship must influence the nature of this framework.

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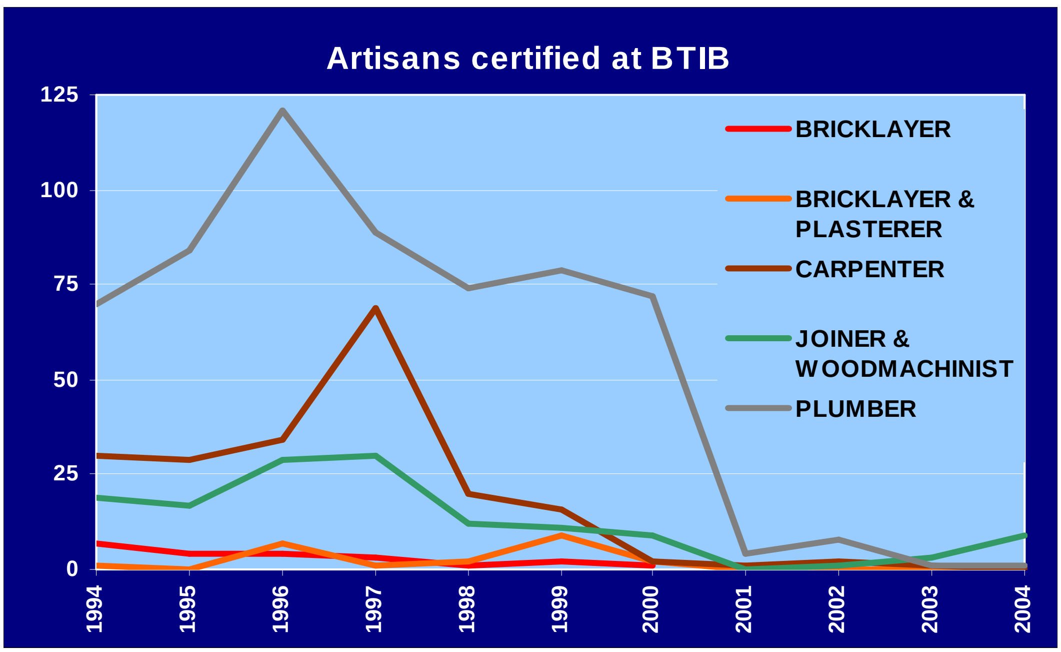
[1] Phillips, 2004:9.
[2] EPWP, 2005:10.
[3] Productivity norms do not have any legislative support; they are a conventionally accepted productivity rate as agreed upon by building industry employees. Task rates have legislative instruments to support them.

The current state of artisanship in the building industry differs significantly from what existed in the 1950s and 1960s. Apprenticeship at present is mostly done through informal training which is in contrast to the formal training administered during the apartheid era. The average number of artisans being trained on a yearly basis in post-apartheid South Africa is lower than what existed in the apartheid era; in 1970, there were over 40,000 skilled trade workers in the building industry as against the trend depicted in figure 1.1.

Fig 1.1: Built environment qualified artisans (1994-2004)



Source: Allyson Lawless, November 2004.

1.2 Problem Statement

The intention of the EPWP to expand its operations to encompass building work requires that task rates are established for all artisan tasks. As a first step towards the establishment of task rates, the EPWP needs to ascertain the trend of productivity norms from the 1950s up to the present time. Unfortunately, artisan productivity norms have not been reviewed frequently in South Africa. More so, some of these norms that are still referred to currently, were established without any adjustment to cater for avoidable delays and idleness on the part of both management and the workforce. There has not been much effort towards comparing both the past and current rates of artisan productivity to that prevailing on the international scene to help the construction sector justify the level and trend of artisan productivities in the country.

The exercise of reviewing productivity norms frequently is necessary for the following reasons:

- Reviewing productivity is an important process for improving it;
- Productivity norms play an important role in tendering.
- The EPWP is kept up to date and are therefore in a position to make productivity adjustments.

Hence, there is the need to establish productivity norms.

1.3 Research Objectives

1.3.1 Specific Objectives

1. To ascertain the past level of baseline artisan productivities in the Built Environment of South Africa and other developed countries.
2. To review artisan training and relate the factors that affect artisan productivity to the South African context.
3. To collect empirical data on labour productivity through direct field observation of selected on-going projects.
4. To critically examine the data and use work study techniques to aid in finding out the exact nature of the factors contributing to the achieved levels of artisan productivity rates for the selected tasks in the building sector of South Africa.

5. To outline measures and conditions under which any proposed improved methods will improve artisan productivity rates.

1.3.2 Purpose

To re-establish baseline artisan productivities for some selected tasks.

1.3.3 Goal

It is hoped that the established productivity norms will help in the monitoring of the performance of employment-intensive projects.

1.4 Research Methodology

The sequential order and manner in which the work study for this Investigational Project proceeded was as follows:

1. A literature survey was carried out on the different definitions and terms of productivity, and the criteria which govern its usage.
2. A desktop study of labour productivity, its measurement, trends and the general factors that affect it was carried out.
3. The historical trend of productivity norms in South Africa and some international countries in Europe were ascertained mostly through the Journal of South Africa. The historical trend in the USA was ascertained through publications from the USA.
4. Direct field observation of some selected artisan tasks. This procedure chronologically involved:
   - I. Recording of field observation.
   - II. Critical examination of the field data to determine actual labour productivities.

III. Develop an improved method of executing artisan task when there was a technical and economic basis for that. This is aimed at reducing work content.

IV. Extrapolation of the actual labour productivities towards establishing possible and optimum labour productivity.

5. Establishing the benchmark/baseline values of productivity and conditions for its achievement based on the above.

1.5 Research Scope

The content of this report is restricted only to the building sector. The field study focused on the construction of two non-residential buildings within the Gauteng province of South Africa. The literature review and work-study focused on the selected artisan tasks below:

1. Face Brick laying
2. Stock Brick laying
3. Standard plastering
4. Painting
5. Tiling

The choice of artisan tasks that was selected for the work study was based on a combination of the characteristics spelt out below:

- The high frequency with which these tasks are carried out within the building sector of South Africa (economic importance).
- The above tasks are dependent on relatively few variables, which can be controlled.
- The simplicity of the task execution.
- The repetitive nature of the handling of materials required for executing these tasks.

- These tasks historically, have required appreciable time for their completion. They are a continuous function of time measured in hours.
- They have the potential to yield substantial savings in man-hours and project cost.

The above characteristics of these tasks make their productivity measurements relatively easier.

1.6 Research Limitations

The literature review in this report will not focus on productivity trends preceding the 1950's. The author of this report was not in a position to dictate the size of the Task Groups that carried out the task execution. It was also impossible for the author to impose a particular work method of task execution that was thought to be the most efficient for the labour force. At the planning stage of this research, brick paving was considered but the author was unable to carry out a field study on this because of the several postponements of the startup date for the execution of the paving task.

1.7 Structure of the Report (Chapter 2 to 7)

Chapter Two

Chapter Two explains the concept of productivity and differentiates this term from other inter related terms such as profitability, performance, efficiency and effectiveness. The essence and factors that affect productivity are discussed. A description of the techniques involved in its measurement is also discussed.

Chapter Three

The main thrust of Chapter Three is to establish what the productivity trends of artisans in South Africa have been since the 1950's. The introductory part of this Chapter reviews the link between training and productivity. There is a discussion on the nature and extent of the apprenticeship system in the apartheid era. The training of apprentices and artisans during this era is reviewed.

Chapter Four

This Chapter assesses the baseline artisan productivity trends in the USA and some countries in Europe. The author relates the work methods, design complexity, and working tools employed in these countries to the levels of productivities. Current baseline productivity data from the USA is also provided in this chapter.

Chapter Five

This Chapter is a description of the fieldwork component of the entire research study. A description of the fieldwork is outlined with details of the field results provided in tabular form.

Chapter Six

An in-depth analysis of the results obtained in Chapter Five is discussed. The results are further compared to the baseline productivity trends detailed in Chapter Three and Four. It concludes with a brainstorming of the factors that contributed to the levels of productivity attained in Chapter Five.

Chapter Seven

In this Chapter, the recommendations of the research study are discussed with a summary and conclusions outlined. Topics for further studies have been suggested.

CHAPTER 2: Literature Review

2.1 Introduction

Chapter Two focuses on the different perspectives on the concept of productivity as expressed by different research publications and the various techniques involved in its measurement. The diverging views on this concept have led to other related terms being used interchangeably with productivity. A thorough analysis of these interrelated terms will be considered to establish that there exists distinct differences in these concepts. The difference between baseline and actual productivity will be outlined. Of all the different types of productivity, it will be demonstrated why labour productivity is crucial and important to the workforce.

Section four of this chapter focuses on the five important reasons why there is the need for an increased labour productivity. In section six, the two major work measurement techniques are described. This chapter concludes by considering the scope of factors that can affect labour productivity.

2.2 The Concept of Productivity

The productivity concept has undergone several evolutions from the time of its inception, two centuries ago.[4] The conventional or traditional concepts, together with the new and modified concepts, are concurrently in use. Several methods of productivity measurement do exist. Literature on this subject reveals that there is a lack of consensus on the productivity concept amongst researchers. The only point of convergence amongst published research has to do with the productivity concept being dependent on the input of an operation and its resultant output. The point of divergence is inherent within the variables that constitute the input and output of the operation. As a result, different

[4]Stefan, 2002:1.

terms/concepts have evolved and used interchangeably with productivity, which on careful analysis must be mutually exclusive; many construction managers apply the productivity term routinely on a daily basis but it is often confused with similar terms. Arguably, productivity is considered as the most important variable that governs the economics of both construction and manufacturing/production activities.

The output component of any operation or task undertaken is dependent on the volume of work done, quality of work done and the value of the work done which is measured in monetary terms. The input component is dependent on the resources consumed in executing the work. The variables of the input resources are the labour cost, labour time utilised, material cost including power (i.e. electricity and fossil fuels), materials utilised and equipment resources measured in monetary terms. The permutation of the output and input variables yields several terms/concepts of which most of the derived terms have all been referred to as productivity. The terms profitability, efficiency, effectiveness and performance (performance is further dependent on quality, flexibility, speed and delivery) have being used interchangeably with the term, productivity. In order to remove the ambiguity surrounding productivity, it is essential to clearly delineate the interface amongst these terms and also to determine their inter relationship.

2.2.1 Productivity

A straightforward operational definition of productivity put forward by Stefan is as follows; ‘a ratio of output quantity (i.e. number of correctly produced products which fulfils their specifications) divided by input quantity (i.e. all type of resources that are consumed in the transformation process)’. Productivity is not a monetary ratio. Stefan continues by writing that productivity is a **relative concept**, which can be said to increase or decrease only when a comparison is made, either with regards to competitors or against an established norm at a certain point in time. This concept of relativity is partly shared by the American Association of Cost Engineers (AACE). They are of the view that productivity is “a relative measure of labor efficiency, either good or bad, when compared to an established base or norm". Whereas the latter definition considers the input variable to be dependent only on labour, the former consider the input variable to be dependent on all resource variables that can be quantified but not in monetary terms. The latter definition is thus more suitable a definition for labour productivity rather than for productivity in general.

With respect to industrial engineering, Stefan generally defines productivity as the relation of output (i.e. produced goods) to input (i.e. consumed resources) in the manufacturing transformation process. Thus the availability and use of input resources is necessary in improving productivity. There is a strong misconception that production is directly proportional to productivity. As a result, it is generally believed that an increase in production reflects higher productivity and vice versa. This is not always the case; where additional input resources are applied onto a system to increase the output (i.e. production) and the magnitude of the additional resources is greater than the output increment, the productivity will be reduced even though there is a production increment. When the magnitude of the output increment is greater than that of the additional input resource, then the direct proportional relation between production and productivity will exist. According to Stefan, improvement in productivity can be achieved in five different ways:

- Output and input increase, but the increase in input is proportionally less than the increase in output.
- Output increases while input stays the same.
- Output increases while input is reduced.
- Output stays the same while input decreases.
- Output decreases while input decreases even more.

The last approach outlined above, when employed will result in lower production. In employment-intensive construction, this approach sometimes becomes a necessary evil when a company is faced with the issue of retrenchment. Usually, the tendency in many companies is to retrench according to payroll, so productivity is weighed up against wages. This approach may increase the profitability of the company. The initial approaches outlined above for productivity increment of an operation or task within a construction environment, require an optimum improvement in the work method, work content and the elimination of unproductive time within the control of management and the labour force.

There are two categories of productivity; partial and total productivity. Partial productivity, which is also referred to as single factor productivity, relates a single measure of output to a single measure of input (labour or capital etc) whereas total productivity which is also known as multi-factor productivity relates a particular measure of output to a group of inputs.[5] Stefan also shares this view. The productivity definition put forward by the AACE is partial (single-factor) productivity and that of Stefan represents a multi-factor productivity.

Whereas most British published research considers productivity as a ratio of output to input, American publications consider it as a ratio of input to output. Thus the latter, mathematically, is the inverse of the former.

2.2.2 Profitability

The goal of every business venture is to earn adequate profit. Profitability is measured in monetary terms but it has no unit since it is a ratio of revenue to cost (i.e profit/assets). This ratio depicts the cost of input resources utilised to generate an output of a certain worth. Thus it is also a ratio of output to input. This notion has led many construction firms to believe that profitability and productivity represent one and the same issue. As a result, these firms have focused all their attention on profitability to the detriment of productivity. Profitability is not generally directly proportional to productivity although it has a productivity component. Profitability measures the price bargaining power of an entity in terms of how much it pays for its inputs and how much it receives in outputs. It

[5] Building Future Council, 2005:4.

is thus possible for profitability to increase tremendously in times of decreasing productivity. Figure 2.1 depicts the relationship between profitability and productivity.
Profitability depends on several other factors such as operation cost (cost of input resources), interest and inflation rate, purchasing price and availability, amongst others. For the same productivity values, profitability can vary significantly because of the following:[6]

- The cost of input resources can differ for the same productivity values. Since the cost of doing business varies from one location to the other, it is possible for the labour cost, for instance, of the same operation with the same productivity to vary as such and also within the same time frame.
- The price of the output component can also differ for the same productivity values. For the same output of productivity values, the selling price of the output can vary tremendously depending on consumer demand for the product.

The underlying difference between these two terms is that whereas profitability is measured in monetary terms, productivity is expressed in physical units.[7] Thus focusing on price recovery alone is not a guarantee that productivity will increase.

2.2.3 Performance

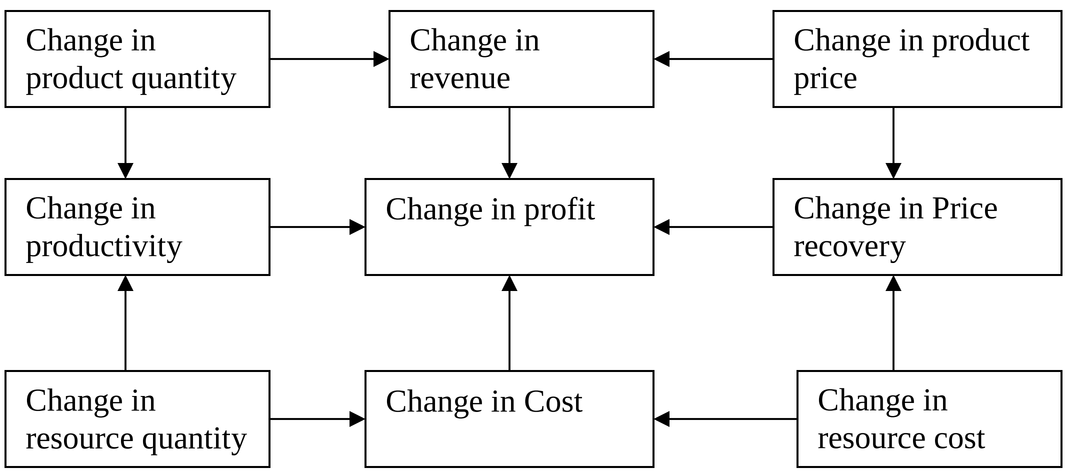
Performance is a broad term that incorporates profitability and productivity. The measurement of any one of these attributes does not wholly reflect performance. Many companies have misunderstood a higher profitability or productivity to mean good performance. There must be a concurrent increase in these attributes to yield any performance improvement.

Some published research also considers performance based on cost, quality, flexibility, dependability and speed.[8] For any company to compete successfully in the open market,

[6]www.Toromontcat.com/seven_factors.asp, 12-05-2006.
[7] Stefan, 2002:4.

these must be their objective cardinal points. The author of this report is of the view that quantity needs also to be factored in. However some of these objectives do reflect profitability and productivity; cost can be considered under profitability whereas speed can be considered under productivity. Quality is inherent in both attributes. In contract administration, quality is predetermined by stipulated specification(s) and as such productivity presupposes that quality must be adhered to; productivity is becoming synonymous with quality. This statement negates the misconception amongst some researchers that an increase in productivity directly increases quality.[9]

Figure 2.1: Productivity relation to profitability.



Source: Stefan, 2002: 4.

Adherence to quality satisfies consumers and this has a greater probability to improve profitability. In construction, quality is also a function of work method and design complexity.

Figure 2.2 shows the relation between productivity and performance objectives. Stefan outlined how some of these performance objectives largely affect the productivity of a task. They are as follows:

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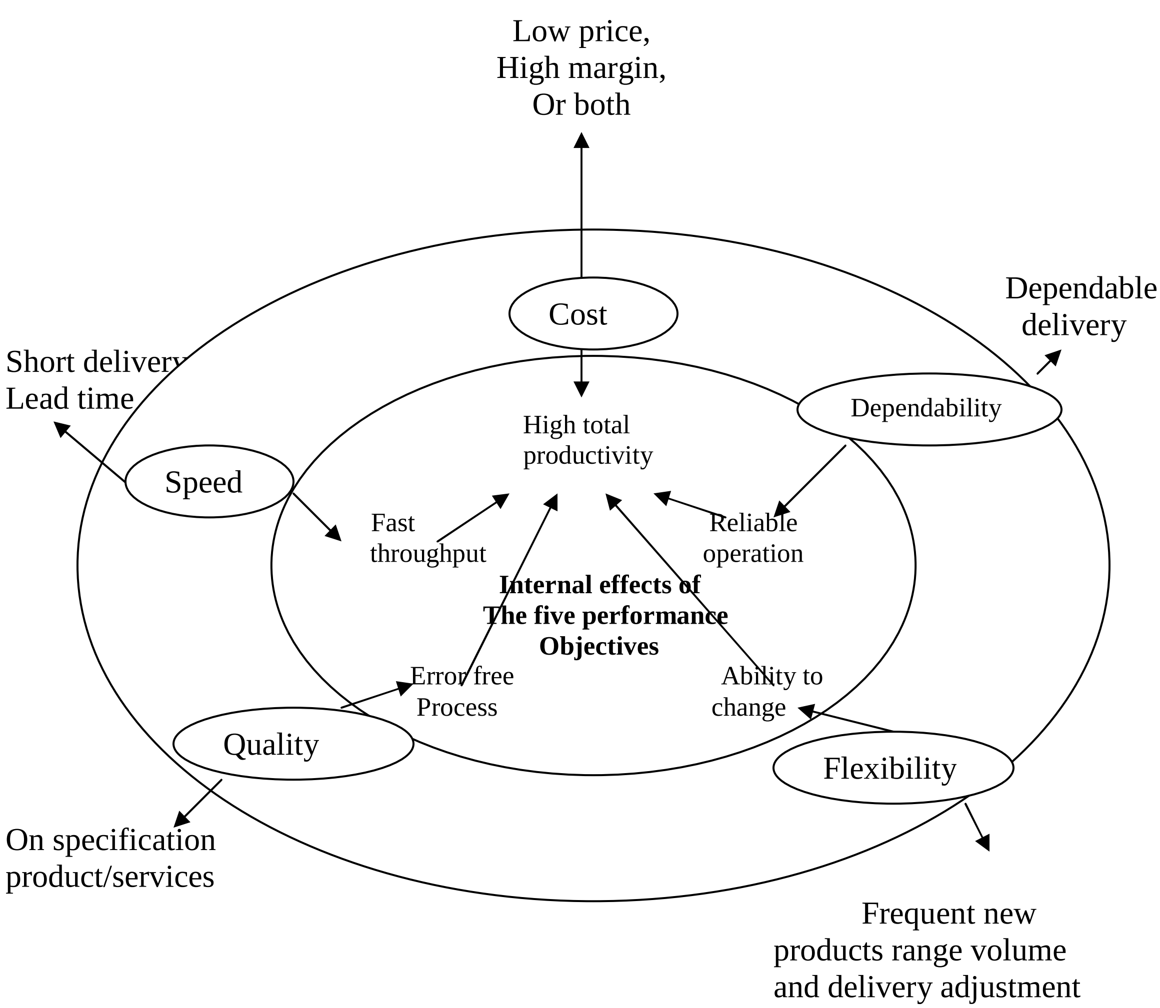
[8]Ibid 4.
[9] Visser, 1990:4.

- *High-quality operations* do not waste time or effort having to re-do things, nor are their internal customers inconvenienced by flawed service.
- *Fast operations* reduce the level of in-process inventory between micro-operations, as well as reducing administrative overhead.
- *Dependable operations* can be relied on to deliver exactly as planned. This eliminates wasteful disruption and allows the other micro-operations to operate efficiently.
- *Flexible operations* adapt to changing circumstances quickly and without disrupting the rest of the operation. Flexible micro operations can also change over between tasks quickly and without wasting time and capacity.

Fig 2.2: Productivity's relation to performance objectives



Source: Stefan, 2002: 5.

2.2.4 Efficiency and Effectiveness

Historically, many researchers have seen productivity as an efficiency concept. Currently, the concept of effectiveness, together with that of efficiency is regarded by many to imply productivity.[10] An executed operation or task is said to be effective if the output achieved conforms to the specified criteria. The value of input resources put in does not matter; it is only dependent on the output variables. Efficiency measures the actual input resources utilised with respect to the expected resources that were estimated to be used. Thus, the efficiency and effectiveness of any project cannot be measured if the objectives of the project at the planning stage do not make an estimate of how much time and money will be required, and also what the quality of work should be. Effectiveness requires a task or an operation to be done correctly whereas efficiency requires the task to be done through the correct means. Therefore, an achievement of effectiveness does not presuppose that efficiency was excellent.

2.2.4.1 An analysis of effectiveness and efficiency

Mathematically put,

$$\text{Effectiveness} = \frac{\text{Actual Output}}{\text{Expected Output}} \quad \text{------------------} \quad (1)$$

Whereas

$$\text{Efficiency} = \frac{\text{Resources expected to be consumed}}{\text{Resources actually consumed}} \quad \text{--------} \quad (2)$$

[10] Arturo, 2004:1.

Although these two equations are ratios and have no units, each of these two terms is not a ratio of output to input and as such is distinct from productivity in this regard. Both equations have components of productivity (i.e. actual output and resources actually consumed) and hence relate to productivity. Therefore an effectiveness ratio of one and an efficiency ratio greater than or equal (≥) to one will increase productivity significantly. If either of the ratios of the two equations or both are less than one, it will not lead to higher productivity. It is thus possible for an effective system to be inefficient.

If the ratios of both equations all equal one, then multiplying equation one by equation two, will yield;

$$1 = \frac{\text{Actual Output}}{\text{Resources actually consumed}} \times \frac{\text{Resources expected to be consumed}}{\text{Expected Output}}$$

This reduces to;

$$1 = \frac{\text{Actual productivity}}{\text{Expected productivity}} \quad \text{---------------} \quad (3)$$

Where expected productivity is referred to as **baseline productivity.** In summary, in order for actual productivity of any operation to equal the baseline productivity, the product of efficiency and effectiveness must equal one (1).

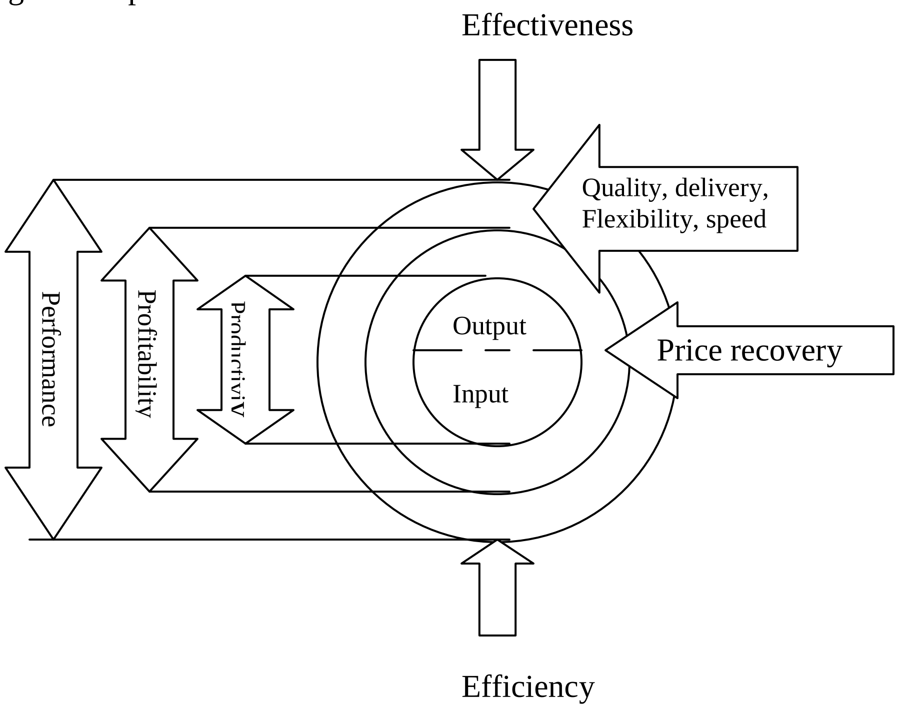
The choice of expected values of input and output in equations 1 and 2 can skew the efficiency and effectiveness ratios and this will have a repercussion on equation 3 in the following ways:

- The baseline productivity will be too high and unrealistic to achieve.

- The actual productivity will continuously exceed the baseline productivity.

Figure 2.3 is a schematic view of the inter relationship existing among the terms/concepts described above.

Fig 2.3: Triple- P model



Source: Stefan, 2002:6.

Fig 2.3 is referred to as the triple-P-model. It depicts the schematic relationship amongst the five terms. In summary, Performance is dependent on productivity, profitability, quality, delivery, speed and flexibility whereas productivity and profitability establish the relationship between the output and input of a process. Efficiency focuses on the input component of the process, whilst effectiveness focuses on the output component of the process.

2.3 Labour Productivity

Labour productivity is a partial productivity since the output is related to one type of input (man-hours). It measures the quantity of work, done to a stipulated specification per unit of man-hours spent. This is commonly referred to as a task rate.[11] It has been established that for the execution of the same task, labour productivity amongst a task-based workforce is generally higher than amongst time-based workers. In the former scenario, the workforce is paid according to the quantity of work done within the day, whereas in the latter, payment is fixed for the day and is irrespective of the magnitude of work done. For the task-based worker, this serves as an incentive to enable him or her to work harder, faster and better in order complete the task earlier. Unfortunately, research has shown that this system in many instances has led to the abuse of workers either through exploitation of workers by management or self-exploitation on the part of the workers. Exploitation can arise under accelerated working conditions.[12] In order to curb this, the labour laws in several countries puts a limit on the quantity of work a person should do in a day. Again, there is a limit on how many hours constitute a fair day's work; in the building and civil sector, this has average eight (8) hours per day in many countries since the 1950's.[13]

In the construction and building sector, labour work requires three key levels of skills requirement namely, low, medium and high skills. In practice, some of the tasks or operations performed within this sector of the economy have been found to interface within the three key levels of skills requirement (see Table 2.1).

[11] Croswell and McCutcheon, 2003:387-400.
[12] Horner and Talhouni, undated: 10-32.
[13] SAB, August 1959:45.

Table 2.1: Skills requirement within the sector

Sector	**Skills requirement**	**Labour-intensity**
Projects with low capacity-building requirements (e.g. some environmental projects and some maintenance projects)	Low	High
Small-scale agriculture-related infrastructure Low-cost housing	Low-medium	High
Community buildings (such as schools, clinics and community halls)	High	High
Water Storm water Sanitation Roads Dams Electrification	Medium-high	Low, but starting to increase
Railways	Medium-high	Low

Source: Phillips et al, 1995.

As can be observed from Table 2.1, the building industry is highly labour-intensive and requires highly skilled labour. This category of labour force is generally referred to as artisans. With respect to employment-intensive construction, an artisan is someone who does skilled work with the hands. Thus, artisan productivity is a subject matter of labour productivity.

2.3.1 Other Productivity terminologies

As defined by International Organisation for Standardisation (ISO):

> Total Quality Management (TQM) is a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society.[14]

Within the concept of Total Quality Management (TQM), the productivity term is classified as follows:

Baseline Productivity

This the output per unit cost of input below which a company or an activity would operate at a loss. It is the average current level productivity from which to measure improvement.

Standard Productivity

It is the accepted or agreed output per person or business unit that generates an acceptable profit.

Benchmark Productivity

This is the productivity achieved by competitors whom you aim to match and surpass.

Best Practice

The best possible or highest productivity achievable in a particular sector or line of business.

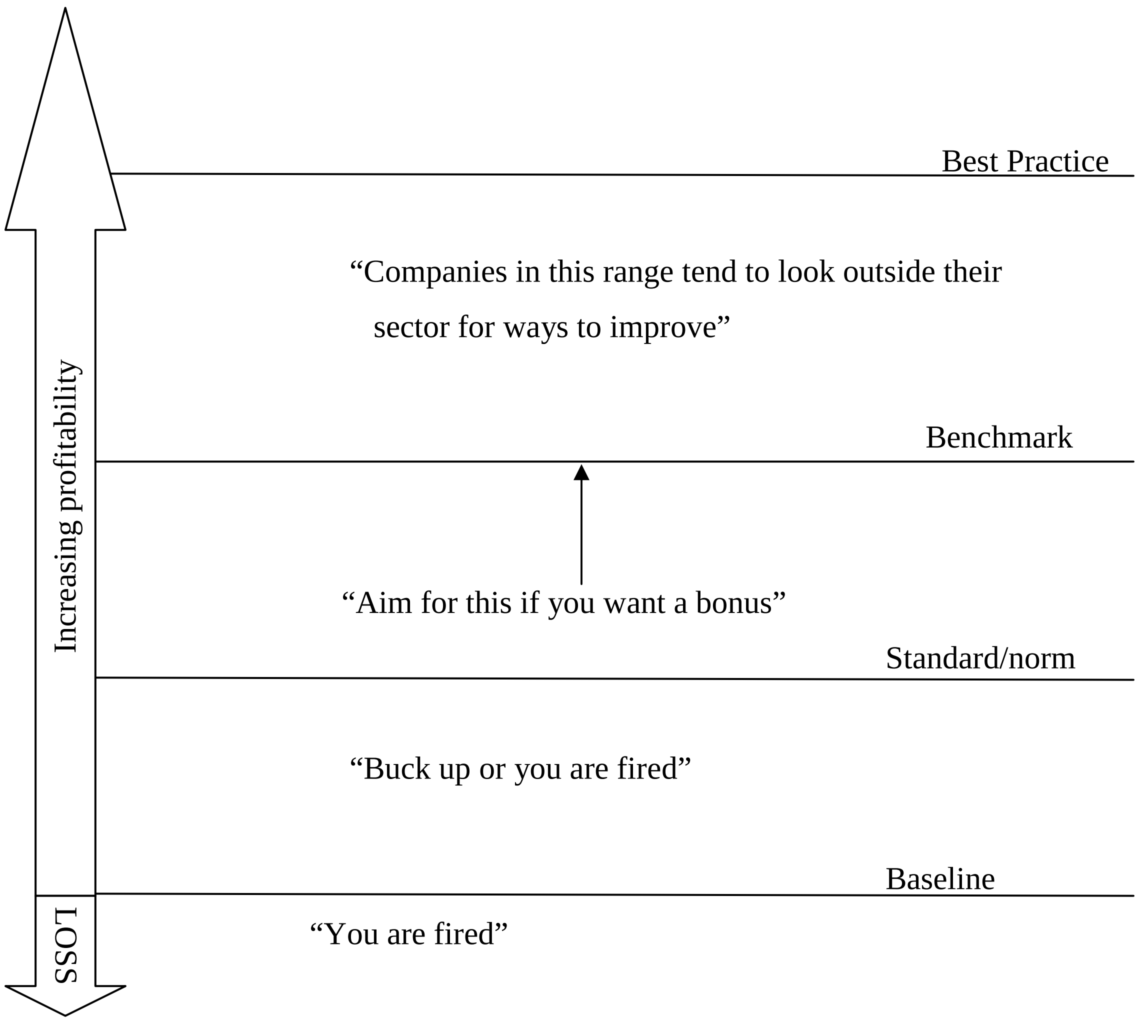
[14] http://en.wikipedia.org/wiki/Total_Quality_Management

2.3.1.1 The context of the usage of the productivity terminologies

These productivity terminologies have been graduated in such a way that the movement of a legal entity through these levels (i.e. in the order in which the author has presented them) indicates a sign of growth (measured in terms of profitability) within that legal entity. In real life situations, an emerging or small building contractor sets up a break-even point (in terms of profitability) which corresponds to a particular minimum productivity level for the workforce. It is this break-even point which is referred to as baseline productivity. A legal company runs at a loss below the baseline and the occurrence of this usually results in the dismissal of the workforce whose output is below this threshold.

Due to the fact that the building industry in South Africa does not have legislative instruments to set task rates (i.e. standards) for building activities, it has been a convention, way before the time scope of this research, for the building industry to have generally accepted productivity rates which are commonly referred to as norms. The growth of such a legal company as demonstrated in the paragraph above will necessarily require it to increase in such a way that it conforms to the productivity norms of the industry. One mechanism usually employed by such companies yearning to achieve productivity norms, is to constantly remind its workforce about the fact that the company is only breaking even and hence the need for them to buck up or else they would be dismissed. The transition from standard productivity, which in this case is the productivity norms, into benchmark productivity usually comes into play when the growing legal entity aims to achieve a higher productivity level than a competing legal entity. Benchmark productivities are usually attained through a financial incentive scheme that pays bonuses to the workforce in exchange for these levels of higher productivity. Legal entities attaining benchmark productivities are usually found within the category of established contractors. In order for this category of contractors to compete internationally, they must aim at matching up with the productivity rates of well established international contractors which is commonly referred to as best practice. Fig 2.4 below shows these productivity levels graphically. This graph is based on the assumption that all other variables that affect profitability are kept constant with the exception of productivity, which is kept directly proportional to profitability.

Fig 2.4: Levels of productivity.



2.4 Essence of increased labour productivity

Productivity is extremely crucial for higher living standards. According to the International Labour Office (ILO) book on work study[15], the basic material well being required of any individual to enjoy a satisfactory standard of living is dependent on:

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[15] ILO, 1979.

- **Food**: This is required to replenish the energy used in working and living every day.
- **Clothing**: Clean clothes to ensure body cleanliness and afford protection against the weather.
- **Shelter**: This is required to give protection under healthy conditions and must be equipped with certain household equipment and furniture.
- **Security**: Security against robbery or violence, against loss of the opportunity to work, against poverty due to illness or old age.
- **Essential Services**: This must include safe drinking water, sanitation, medical care, public transport and educational and cultural facilities that would ensure that every individual develops to his or her full capacity.

It has been mentioned under Section 2.2.1 of this report that higher productivity can lead to an increase in production**.** Another way to achieve increased production is through an increase in employment but this report will not focus on employment creation. In a task-based labour force construction environment where higher productivity results in production increment, an increased labour productivity of an individual can result in higher salary wages. This will ensure that such an individual's potential to live above the stipulated ILO basic requirements for a satisfactory standard of living is attained. Food, shelter and clothing are the responsibility of an individual who is not legally a minor. The increased salary wage of such an individual will ensure that these basic needs are met. Security and Essential services, according to the ILO, are the responsibility of governments. The tax component on the increased salaries can be used by responsible governments to provide the security and essential services required.

The ILO states further that:

- When higher agriculture productivity results in an increment in agriculture products, food is abundant and cheaper to purchase.
- An increase in industrial productivity will also ensure that clothing and shelter will be available and cheaper to acquire.

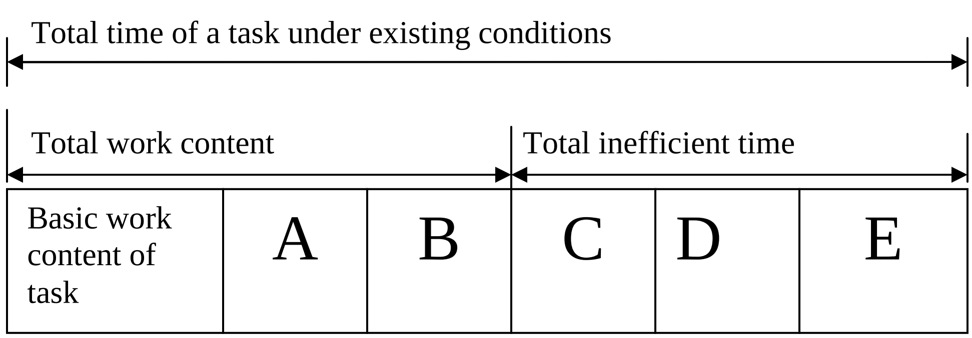
- Responsible governments will provide more security and essential services when productivity increases.

It must also be mentioned that when a legal entity's profitability increases as a result of increased productivity and subsequent production increment, governments generate additional money from the tax component of gross profit declared.

2.5 The time content of a task

Theoretically, the amount of work required of any given task is dependent on the basic work content of the said task. The basic work content is the minimum irreducible time required to perform a given task. In reality, the time content of a task goes beyond the scope of the basic work content; it is also dependent on the extra work content, idle time due to the inefficiencies of management and the work force. Extra work content arises as a result of defects in product design, lack of clarity in specification and poor work method and processes. In the ILO Work study publication of 1979, no mention is made of unavoidable delays that can be caused by a force majeure (an Act of God), as a part of the time content of a task.[16] Although this factor is beyond the means of management or workforce, it affects productivity and hence needs to be factored into the time framework. Figure 2.5 is a modified version of the ILO schematic diagram of the time content of a task.

Fig 2.5: Time content of task.



[16] ILO, 1979:14.

Where:

A is the work content added by defects in design or specification of product.

B is the work content added by inefficient methods of manufacture or operations.

C is ineffective time due to the shortcomings of management.

D is the ineffective time within the control of the worker.

E is the ineffective time due to an Act of God.

2.6 Productivity measurement techniques

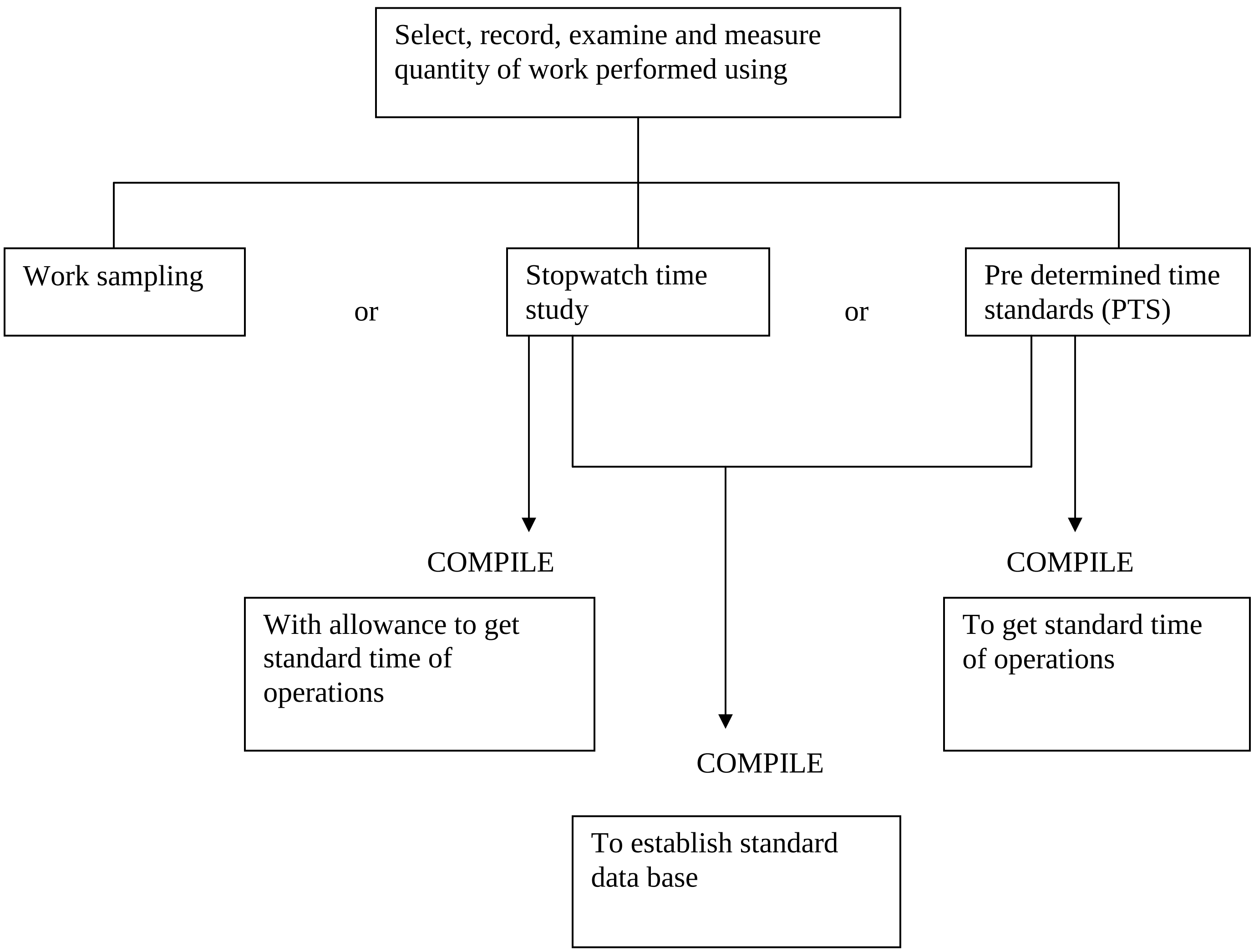
The establishment of baseline productivity norms or random productivity measurements for any construction task requires the tools of work measurement. Work measurement requires the use of techniques designed to establish the time for a qualified worker to execute a specified task or operation at a defined level of performance (ILO, 1979). The application of work measurement techniques exposes management inefficiencies and the behavior of the work force. Many published researchers, including the ILO, are of the view that the causes of avoidable delays on construction sites in most instances are due directly to management inefficiencies. Work study employs method study and work measurement techniques to study human work in all its contexts so as to ultimately effect improvement. Method study specifically aims at optimum improvement in work methods and work content. According to the ILO, the importance of work measurement in establishing norms is as follows:

- To compare the efficiency of alternative methods;
- To balance the work of members of a team;
- To provide information on which the planning and scheduling of production can be based, including the plant and labour requirements for carrying out the programme of work and the utilization of available capacity;
- To provide information on which estimates, for tenders, selling prices and delivery promises can be based;
- To set standards of machine utilisation and labour performance which can be used for any of the above purposes and as a basis for incentive schemes;

* To provide information for labour-cost control and to enable standard cost to be fixed and maintained.

Figure 2.6 shows the basic steps and techniques involved in work measurement. The fourth work measurement technique, which is not shown in Figure 2.6, is called the standard data technique. This report will discuss work sampling and the time study techniques.

Fig 2.6: Steps and techniques of work measurement.



Source: ILO, 1979: 192.

2.6.1 Work sampling technique

The application of this technique on an employment-intensive construction site is basically to measure how much of the available time was utilised productively and also to determine the cause of unavoidable delays. Observations of workers on a particular task are carried out at random intervals. For each observation, it is noted if there are any stoppages and the reason for the idleness. One precaution that needs to be taken by a work-study person is to pre-determine what behavior of the workforce constitutes productive work prior to the start of the observation in order to reduce bias. From these observations, the percentage of time spent doing productive and idle work is deduced. From a statistical point of view, the greater the number of observations made at random (i.e large sample size), the higher the probability that these number of observations will reflect the reality, within a certain margin of error.

This technique as shown in Figure 2.6 does not measure productivity and hence cannot be used to establish baseline productivity norms. When using this technique, there is no basis to directly correlate the amount of productive time observed or attributed to productivity since there is no measurement of output. Work sampling is also referred to in some published research as random observation method, snap-reading method and activity sampling. It is a relatively low cost operation and is widely used in the manufacturing, office and servicing operations.

2.6.2 Time study technique

This technique is one of the most widely used techniques in establishing baseline productivity norms. It requires very basic equipment such as a stopwatch and clerical stationery (clip/study board, staplers, punches, pencils and rulers etc) for its measurement. The nature and type of equipment required for this technique, is generally dependent on the type of task to be examined. It records and analyses the input times and output quantities of a clearly defined task under specified conditions in order to determine standard times and quantities for specific tasks. The need to establish baseline productivity norms of certain tasks using time study technique arises as a result of the factors listed below by the ILO:[17]

- When a new task emerges and no time studies have been carried out;
- When there are a changes in material used for the task, work method and work content;
- When a complaint has been received from a worker or workers' representative about the time standard for an operation. In many cases, the artisans' make such complaints to their foremen;
- When a particular operation appears to be a "bottleneck" holding up subsequent symbiotic operations and possibly (through accumulations of work in process behind it) previous operations;
- When standard times are required before an incentive scheme is introduced;
- When a piece of equipment appears to be idle for an excessive time or its output is low, and it therefore becomes necessary to investigate the method of its use;
- When a task or an operation needs studying as a preliminary to making a method study, or to compare the efficiency of two proposed methods;
- When the cost of a particular task appears to be excessive.

In addition to the above factors, the author is of the view that these baseline norms using this technique should be established:

- When the project external environment such as climatic conditions are adverse (i.e. becomes severe). The severity of this must be dependent on the extent of the deviation of these climatic conditions from the normal. On most construction sites, extreme climatic conditions either disrupt or interrupt the execution of tasks. When there is an interruption instead of a disruption, it is necessary to standardise the time required for task execution under different measured extreme climatic conditions.
- When the inherent qualities within a worker or workers improve as a result of new improved training.

[17] Ibid 219.

The relationship between the time-study person and the worker often determines the quality and success of the time-study results. The time-study man with the support of a foreman must establish a cordial relationship with the workers by truly unfolding the intent of the studies. This will ensure that the workers go about their activities normally and accommodate the study man. The time-study person focuses on qualified average workers when establishing task norms. Qualified workers usually have different inherent work speed and, as such, the observed time must be adjusted to accommodate for some of these inherent qualities in a qualified worker.

Below are the steps stipulated by the ILO for carrying out a time study:

1. Select the task for which the baseline productivity norm is required;
2. Obtain and record all the necessary vital information that pertains to the said task and project on a study form. This information required on the study form must include project name, task name, date of study, name of artisan or operator;
3. Record by completely describing the work method of the task, complexity of task design and a breakdown of the subtasks. There is the need to ensure that the proposed work method is the most optimum work method available;
4. Determine the sample size. This in most cases will be dependent on the number of days of observation suitable for the proposed task study. This requires a statistical approach in determining the sample size;
5. Using the required time, clerical and output quantity equipment, measure the available time taken to do a specified, legislative (if any) piece of work per day. Available time is the total time minus unavoidable delays;
6. Deduce productive and idle time from available time;
7. Determine the allowance to be made over and above the productive time for the said task;
8. For each observation, compute output quantity over adjusted productive time to determine the productivity for the said task.

2.7 Baseline productivity framework

In the publication titled “Benchmarking of Labor-intensive Construction Activities: Lean Construction and Fundamental Principles of Workforce Management”, the authors Thomas et al, applied a baseline productivity site-based model of Ivica Zavrski (University of Croatia: 2002) to a series of construction work that took place in the United States, Brazil and Turkey. Thomas et al state that ‘This model was an analytical approach to compare labor productivity in one country to that of another’.[18]

A thorough review of this model indicates that the process involved in the establishment of the baseline productivity did not incorporate adjustments that were necessary to cater for avoidable delays. It was based on the assumption that the daily productivity values used in determining the baseline norm(s) would have little or no disruptions. Below is a full text of the five major steps used by Ivica Zavrski in the modeling for establishing the baseline productivity of a task:

1. Determine the number of workdays that comprise 10% of the total workdays observed;
2. Round this number to the next highest odd number; this number should not be less than 5. This number, n, defines the size of (or number of workdays in) the baseline subset;
3. The contents of the baseline subset are the n workdays that have the highest daily production or output;
4. Calculate the sum of the work hours and quantities for these n workdays;
5. The baseline productivity is the work hours divided by the quantities contained in the baseline subset.

As much as the choice of the highest daily productivity values are used in the modeling, it is only an indication that the magnitude of avoidable delay(s) is/are smaller relative to the unused daily productivity values; the absolute magnitude of the avoidable delay(s) is

[18] Thomas et al, 2002:2.

unknown. In order for this model to reflect baseline norms, the model must refine the daily productivities to reflect only productive time used. When this is achieved, it will ensure that the baseline productivities are a true reflection of the competency of only the workforce since managerial inefficiencies would have been annulled.

Horner and Talhouni, are of the view that productivity measured weekly requires an observer to be constantly on site to record the cause and duration of delays which last for more than five (5) minutes, whilst with regards to daily productivity measurements, the observer should visit the site at the close of the day to question the crew about the cause and duration of delays that last for more than thirty minutes.[19] Daily productivity values based on the latter approach can result in a high degree of inaccuracy, variability and a low reliability on the productivity since it will be difficult to ascertain the sincerity of the crew. In effect, the crew will be in charge of measuring the productive time concurrently with the execution of the task. This will not be right. Horner and Talhouni contradict themselves in the same report by rightly assessing the factors that will ensure an accurate measurement of productivity. They state that an accurate productivity value depends on:

- How precise the productivity definition is;
- The accuracy with which the output is measured;
- The accuracy with which the man hours input to the task is measured;
- The number of observations.

The application of time study technique on a given task that results in inaccurate daily productivity values may lead to a higher variability in the productivity values. It is not uncommon to observe on a particular site that the productivity of a given activity varies by +/- 200% from one day to the next and by +/-500% from one site to the next.[20]

[19] Horner & Talhouni, undated: 5.
[20] Ibid 6.

2.8 Factors affecting artisan productivity

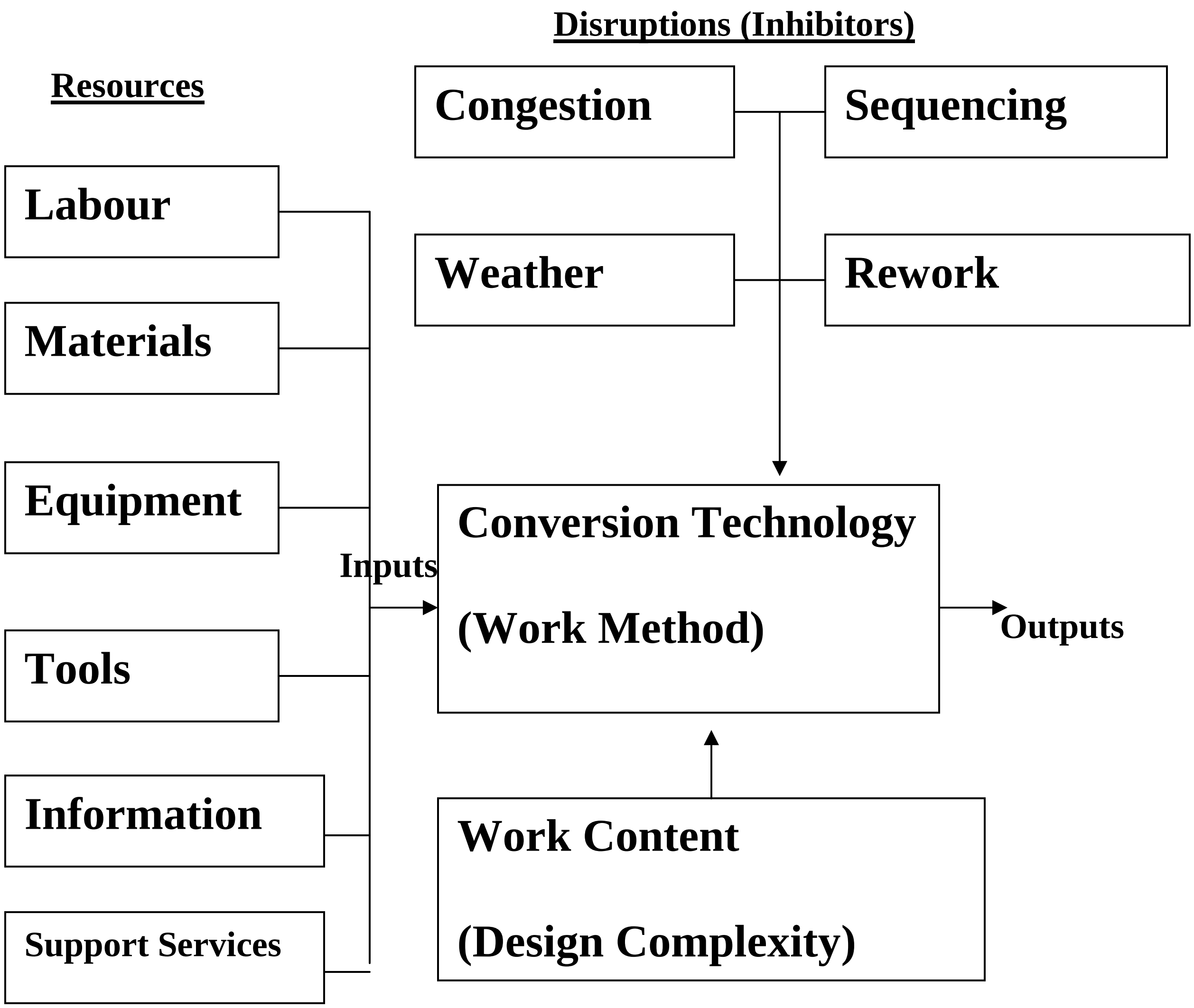
Artisanship falls under the labour workforce and as such the factors that do affect the labour workforce on a construction site are familiar to artisanship. It has already been mentioned in this report that artisan productivity is a subject matter of labour productivity.

There are two productivity models; the factor-resource model and the lean construction principles basically outline what needs to be put right in order to improve productivity at the activity or task-based level[21]. There is little difference between these two models. Lean construction principles focus on reducing the cycle time of an activity/task through the elimination of output variability. This is achieved by improving flow reliability, eliminating waste and simplifying the task process. It further requires the provision of adequate resources (material, labour, information and equipment etc) on time and at the right place on the construction site. With regard to information flow, it is essential that this be communicated in the simplest form that will be understood by all. Improving upon the work method, work layout and eliminating disruptions when possible are all inclusive in the lean construction principles.

The factor-resource model outlines the input resources and what factors can act on this system during its transformation into output. The two major categories of factors are the conversion technology (work method) and disruption. Figure 2.7 shows the interactive nature of the factors that yield an output and Table 2.2 clearly distinguishes between factor resource model and lean construction principles; work content is not addressed by the lean construction principles.

[21] Thomas et al, 2002:4-9.

Figure 2.7: Factor-resource model.



Source: Thomas et al, 2002: 7.

Table 2.2: Relationship between lean construction principles and factor-resource model

Factor-Resource Model	**Lean Construction Principles**
Resources	• Improve flow reliability • Practice Just-In-Time (JIT) material delivery • Use pull-driven scheduling
Disruptions	• Improve flow reliability
Conversion Technology	• Eliminate waste • Simplify operations
Work Content	
	• Apply sizing criterion

Source: Thomas et al, 2002: 8.

Sizing criterion, also called unloading, is applied by ensuring that the workforce performs below their maximum capacity and maintains this output in order to eliminate output variability.[22] The argument of Thomas et al is that it is impossible for a crew to work at their maximum capacity on a daily basis and hence the sizing criterion principle is the only way to reduce output variability. Although this report does not share the views of Thomas et al, as has been proposed by many other authors, it can be more profitable to reduce the crew size to work at maximum capacity on a daily basis rather than to reduce their maximum capacity and still maintain the same crew size.

The factors that affect artisan productivity, and for that matter labour productivity, are not definite or constant. These factors vary in number and intensity from one construction site to another. Pilcher[23] identified seventy-six (76) such factors whereas Horner and Talhourni outlined thirty. Most authors who have researched the factors affecting productivity qualitatively cover the same scope. The difference quantitatively is due to some factors being broken down further into sub-factors and being counted as such.

[22] According to Thomas et al, this initial concept on sizing criterion was first put forward by Ballard et al, 1998.
[23]The works of Pilcher was mentioned in the report of Horner and Talhourni. The author of this current report did not have access to the works of Pilcher.

Again, these factors have been classified into different categories by different authors in some instances. Below is a description of two such classifications.

Classification A

Horner and Talhouni initially classified these factors into two; those factors that were seen to be under the control of management and those that were project & environmental related. He identified 16 factors each on both sides. All the thirty factors that were considered to affect labour productivity have been listed in Table 2.3. It can be seen that some of the factors overlap in the two groups. Some of the factors can be clustered together and renamed (e.g. the first five items under management controlled can be grouped together and called ‘nature of labour force’).

Table 2.3: Factors affecting labour productivity.

Management Controlled	Project related and environmental
Skill of Labour force	Skill of labour force
Size of labour force	Size of project
Balance of labour force	Absenteeism
Morale of labour force	Unemployment
Motivation of labour force	Lack of motivation
Union attitudes	Union attitudes
Working hours	Weather
Welfare provisions	National/Local politics
Continuity	Continuity of work for trades
Working methods	Complexity
Mechanisation	Buildability
Availability of resources	Availability of resources
Quality of finished work	Quality specified
Performance of subcontractors	Holidays
Relationship with client	Type of contract
Degree of management control	Variations

Source: Horner and Talhouni, undated: 7.

Classification B

Horner and Talhouni regrouped these factors as follows; people related, project related and site related. What they basically did was to classify the management-controlled group into two; i.e. people related and site related; they are dependent on the inherent features within the workforce and management (i.e. skills, quality of workmanship and speed). The contractor or management has complete control over the variables in these two groups whereas he has virtually no grip on the project related variables. Project related variables could be either due to an act of God or government policies etc. The essential ones indicated by Horner and Talhouni were outlined as follows:

- Working hours and shift patterns;
- Delays or disruption due to materials or equipment shortages, lack of instructions or congestion;
- Continuity resulting from careful sequencing;
- Conditions of employment affecting the quality and motivation of the workforce;
- Labour imbalance and absenteeism and its effect (if any) on the learning curve;
- Degree of mechanization stemming from an awareness of state-of-the-art technology.

These factors can also be re-grouped under the headings, internal and external factors. Internal factors will consider those factors that are within the control of the workforce whereas the external factors will be those outside the control of the workforce. When this re-grouping is carried out within the management controlled category as shown in Table 2. 3 above, it becomes clearer why the focus of productivity improvement must first start with management and subsequently the workforce.

2.8 Conclusion

The concept of productivity is a unique concept/term, which must not be used interchangeably with other terms such as profitability, performance, efficiency, and effectiveness irrespective of their relatedness as established under Section 2.1. Labour productivity, which is one of the components of productivity as whole, when improved upon, can improve the ability to meet the basic needs of mankind in the required quantities; these needs are food, clothing, shelter, security and essential services.

The choice of time-study technique over work sampling technique in work measurement arises when the focus is on establishing how much work can be done in a day. Work sampling technique is used to determine the component of available time used to do productive work and hence cannot be used in measuring productivity. There is variability in the number of factors that can affect the labour productivity from one project to another. These factors are diverse and must as such be considered based on the classification model used.

The clarity of the literature review on productivity, emphasizes the need for the author during the period of research to consider labour productivity as a single factor productivity based on a single input resource (i.e. time utilised by labour) relative to a particular output resource (i.e. amount of work done by labour). Due to the fact that the work measurement technique is not suitable for measuring productivity and hence establishing productivity norms, the research methodology focuses on the use of time study technique to measure productivity. In this regard, the methodology reviews work studies in the past, based mainly on time study technique in measuring productivity. Although the Ivica Zavrski model, which is based on a time study technique for the establishment of productivity norms, is a good model, the current research methodology adheres to the model that is based on the ILO guidelines. This is due to the fact that published work study on productivity within the time frame under review in this report has not been based on the Ivica Zavrski model; this will allow for easy comparison of the fieldwork results from this research with past work studies.

CHAPTER 3:

The state of Artisanship in South Africa's Building Sector

3.1 Introduction

Training provided to apprentices is to ensure that they acquire the requisite technical skills to perform a particular task(s) to specification. The transition from an apprenticeship to artisanship is enriched by the gaining of experience with respect to the performance of the task in question. This experience is manifested not only in terms of the high quality of work done, but also by the improved pace at which the task is completed. According to Ochse Rhona, psychologists are of the view that an individual gains automaticity, which develops through experience, when that individual performs a task involving physical and mental actions without giving them conscious attention[24]. It can therefore be deduced that automaticity is the highest level of experience and hence, the level of productivity that must correspond to automaticity should be maximum. Thus, there is the potential for increased productivity when training is provided.

Skills inadequacy, which encompasses poor levels of skills, and skills shortage become very severe whenever there is an economic boom in the building industry. The lack of proper training of apprentices is the main cause of the skills inadequacies currently facing South Africa. Informal training of apprentices in South Africa has contributed more to the skills inadequacy than formal training. Informal training generally lacks the classroom component of the training, which normally deals with the introduction of the trade theories to apprentices. It also does not allow an individual to learn the basic skills that are adequately needed to perform a task. The use of an inadequate skilled workforce in the routine performance of tasks does not guarantee experience. Formal training usually ensures that there is a legislative instrument which outlines the format and procedure that

[24] Ochse, 1994: 159.

apprenticeship training should follow. Most importantly, it ensures that apprentices are trained by an accredited trainer.

Chapter Three will outline the evolution that has taken place in the apprenticeship system since its inception in the early 1920's. The nature and the trend of the conditions of apprenticeship are also assessed. The inability of the building sector to attract apprentices both in number and quality has been attributed to several factors, which still exist. Efforts made by the sector to attract prospective apprentices yielded some positive results. By the end of the chapter, it will be realised that, irrespective of the shortage of artisans and apprentices, the productivity figures were quite encouraging in the 1950's through to the 1970's. During this period artisans were attracted from some European countries such as Holland, Italy, Portugal and the UK.

3.2 The apprenticeship system

An apprentice in the early 19th century was referred to as someone who was in agreement to work for a skilled person for a particular period of time at a relatively low pay wage, in order to learn that person's skills.[25] Today, especially in most developed countries, it has evolved and now transcends beyond the boundaries of an agreement; it is now contractual with implications for non-performance. Unlike in developed countries, most apprenticeship systems in third world countries do not have any legislative backing. This in particular is a common feature within the informal construction sector. In the informal sector of Ghana for instance, the apprentice is not entitled to any monthly salary and, more so, he/she is required to pay for the cost of training. The apprenticeship system is more contractual within the formal sector than within the informal sector. The apprenticeship system of the 19th century focused on the recruitment of minors into several trades.

[25] Cambridge Advanced Learners Dictionary (http://dictionary.cambridge.org/define/asp?key=CALD)

3.2.1 The building industry apprenticeship

Until the abolishment of the apprenticeship system in South Africa, there was a legislative instrument to enforce it. This dates back to the 1920's. The control of the apprenticeship system was localised from the time of its inception until 1956 when a national pattern for training was developed and published in the Government Gazette No. 5792 of 28th December 1956. Prior to this new development, the conditions of apprenticeship varied from one area to another. It was thus required of employers to tediously search through numerous government notices for what conditions applied when transferring an apprentice from one zone to another. The process towards the attainment of a nationally controlled pattern for the apprenticeship scheme began in 1925; it was not envisaged at that time that it was going to take over thirty years for this to materialise. Below is a chronological order of events that took place from 1922, which finally resulted in a nationally controlled apprentice scheme:[26]

- 1922: The Apprenticeship Act was passed.
- 1925: The executives of the National Federation of Building Trade Employees (NFBTE) currently referred to as the Building Industry Federation of South Africa (BIFSA), together with various localised apprenticeship committees all over the country requested the government to hold a conference to discuss measures to be taken to bring about uniformity and co-operation amongst the various districts.
- 1926: It was proposed that a National Apprenticeship Committee of an advisory character be formed to provide real service in co-ordination of the various training systems in vogue and in securing uniformity in the training of apprentices, designation of trades and other essentials.
- 1928: The first-ever general conference since the passing of the Apprenticeship Act of 1922 for all Apprenticeship committees in the Union was held in September of 1928.
- 1944: An amendment to the Apprenticeship Act of 1944 by Parliament led to the establishment of the National Apprenticeship Board (NAB).

[26] SAB, 1957:11.

- 1945: The NAB made it their goal to ensure that there was equity and uniformity in the wages paid to apprentices throughout the union.
- 1946: The NFBTE started serious brainstorming with the aim of introducing uniform trade designation and courses of training.
- 1951: The intention to set-up a National Apprenticeship Committee (NAC) was well received by all the stakeholders including the sub-committees in the local areas. This resulted in the Apprenticeship Amendment Act of 1951.
- 1954: The NAC was established as a result of the Apprenticeship Amendment Act of 1951 by Parliament. The first meeting of the NAC was held on the 21st of June 1954.
- 1956: A detailed list of designated trades and national conditions required to control the apprenticeship system was published in the Government Gazette of 14th September 1956. This became legally enforceable on the 28th December of the same year.

The local apprenticeship committees were de-established and transformed into subcommittees under the NAC as a result of this new direction. There were twenty-two trades on the designated list, of which seven were new trades. These new trades included Leadlight-making, Letter cutting & decoration, Marble Masonry, Reconstructed Stone and Terrazzo Working, Sign writing and Shop fitting (Architectural Metal Working). Some of the old trades that had existed all this while were modified to meet the new challenges that were engulfing the Industry. The modified trades, with their old names in brackets were Painting & Decoration (Painting, Decoration and Paperhanging), Shop fitting (Wood works), Stone Masonry (Masonry), Wall and Floor Tiling (Wall Tiling and Marble Fixing) and Leadlight Making (Glazing and Leadlight Making). Some of the old wet trades such as Plastering and Brickwork remained unchanged. The Lift Mechanic trade was removed from the designated trade list.

Currently, there are over six hundred designated trades that have been published in the Government Gazette covering the entire government sector. Of this number, seventeen (17) make up the building industry designated trade list and this shows a reduction in the number of trades listed from 1956 to date. Table 3.1 is a list of these trades and their codes. Although Table 3.1 has some of the line items with the same trade name, they have different codes. The codes containing the alphabet ‘s’ refers to those trades in Namibia (formerly South West Africa) that used to have their trade testing administered by the Central Organisation of Trade Test (COTT, now referred to as INDLELA), South Africa.

In the era of apartheid South Africa, white artisans found within the building and construction sector had their training through the apprenticeship system. The apprenticeship system, which was the main source of industrial training, was unfairly racial and the white race benefited most; these colleges were administered by racially different education departments. Whereas the White race benefited from highly skilled training in fields such as craft and related traded, managerial, professional and technical occupations, the historically disadvantaged suffered from poorly skilled training in operative and clerical occupations. The Job Reservation Act was solely responsible for these divisions. The native Bantu and coloured artisan were restricted to working in certain areas.

Table 3.1: Building Industry designated trade list.

CODE	TRADE NAME (AS PER GOVERNMENT GAZETTE)	INDUSTRY
B009	BRICKLAYER	BUILDING
BS05	BRICKLAYER	BUILDING
B010	BRICKLAYER & PLASTERER	BUILDING
BS06	BRICKLAYER AND PLASTERER	BUILDING
B015	CARPENTER	BUILDING
BS11	CARPENTER	BUILDING
B016	CARPENTER & JOINER	BUILDING
BS12	CARPENTER AND JOINER	BUILDING
ES01	ELECTRICAL WIREMAN	BUILDING
E005	ELECTRICIAN (CONSTRUCTION)	BUILDING
B014	JOINER	BUILDING
BS10	JOINER	BUILDING
B160	JOINER AND WOODMACHINIST	BUILDING
B013	PAINTER & DECORATOR	BUILDING
BS09	PAINTER AND DECORATOR	BUILDING
B012	PLASTERER	BUILDING
BS08	PLASTERER	BUILDING
B201	PLASTERER AND TILER	BUILDING
B008	PLUMBER	BUILDING
BS03	PLUMBER	BUILDING
BS04	PLUMBER AND SHEET-METAL WORKER	BUILDING
B161	ROOFER	BUILDING
BS07	SHEETMETAL WORKER	BUILDING
B017	SHOPFITTER	BUILDING
B007	SIGNWRITER	BUILDING
BS02	SIGNWRITER	BUILDING
B006	STONE MASON	BUILDING
B011	WALL & FLOOR TILER	BUILDING
B005	WOODMACHINIST	BUILDING
BS01	WOODMACHINIST	BUILDING

Source: COTT/INDLEDLA, 2006.

3.2.2 Conditions of Apprenticeship

By virtue of the new provisions as published in the Government Gazette of 28th December 1956, all the applicable conditions to the apprenticeship system were uniform throughout the country. The only exception to this norm had to do with the basic wages structure. The different wage structure was as a result of the variations in living conditions from one area to the other. There were two major pay structures and this is clearly depicted in Table 3.2. The wages as shown in this table reflect the 1957 figures for apprentices. An employer was allowed to deviate from these figures on condition that it showed an upward trend. By July 1960, the weekly wage structure ranged from £ 3, 5s. 9d from the first year to £ 8, 10s in the fifth year. An apprentice was employed as a time-based worker and not as a task-based worker.

Table 3.2: 1957 weekly wages for apprentices.

Year	**Magisterial Districts of Albany, King William's Town, Queenstown and Worcester**	**Other Areas**
1st year	£ 2. 0. 0	£ 2. 5. 0
2nd year	£ 2. 6. 0	£ 2. 12. 6
3rd year	£ 2. 13. 0	£ 3. 0. 0
4th year	£ 3. 6. 6	£ 3. 15. 0
5th year	£ 4. 0. 0	£ 4. 10. 0

Source: SAB, January 1957.

The requirement for entry into an apprenticeship as of 1957 was that the prospective apprentice must be fifteen years of age (i.e. a minor) and must have a Standard Six Certificate. The duration for apprenticeship was pegged at five years. Depending on the pre-knowledge of the proposed trade that a prospective applicant had or a technical certificate, a reduction of three to twelve months from the five-year duration was possible. Apart from the training provided by the employer, it was mandatory under certain conditions for the apprentice to attend educational/ technical classes. An apprentice was exempted from this attendance if he already had attained a pass in the National Technical Certificate I & II during the period of apprenticeship. Classes for the first two years of apprenticeship required eight hours per day, once a week (i.e. 1 day per 5 day week). The employer was required by law to make advance payment on behalf of the apprentice towards the attendance of classes and was subsequently reimbursed through deductions from the monthly salary of the apprentice. A satisfactory progress from the technical training was enough grounds for an apprentice to be refunded and this served as an incentive scheme. It was required of all apprentices to write a qualifying trade exam when they were in their 4th year of study.

3.2.3 Fallout from the conditions of apprenticeship

Prior to the condition underlining the compulsory trade test, an apprentice became an artisan after completion of a five-year stewardship. Although most of the 1957 conditions pertaining to the apprenticeship system were accepted by the Congress of the NFBTE, serious concern was raised about the aspect of the qualifying trade exams; a section of congress favoured the suspension of the trade test until a modified form was introduced. Some of those who opposed this condition believed that a compulsory qualifying trade test would deny some apprentices, who worked effectively with their hands and were practically good but did not have the astuteness to study trade theories and technical studies in order to pass the exams, the opportunity to be artisans. This view was also supported by those who were convinced that the trade test, which started in January of 1953 on a voluntary basis, was not a true reflection of the capabilities of what the apprentice could do as an artisan. More so, the pass rate for those who voluntarily undertook the exams was not encouraging, yet they were still performing well as artisans in the industry. The other argument, which was not in support of the new conditions, had its basis firmly rooted in the lack of continuous testing or examination of apprentices during their apprenticeship to ascertain their progress. Those who were of this opinion, recommended an introduction of progress testing during the first four years of apprenticeship. Ultimately, the Congress Committee on apprenticeship matters approved the compulsory undertaking of a trade test in the penultimate year.

Table 3.3 is a summary of the entire trade test that was conducted between January 1953 and September 1956. The higher patronage by apprentices in the carpentry and wood working trades was reflected in the percentage passes. Brick-laying and Plastering which was and still is one of the core activities pursued on a building site had the lowest percentage pass, whereas the wood machining trade which was the most highly patronized, but not a core building activity had the highest percentage pass rate. The poor average pass rate of 32.4% was largely attributed to the poor quality of the applicants who chose these trades as a profession. It was said that most of the applicants were those who for one reason or another failed to pursue a university degree and were left with only this option. Some members of NFBTE believed that some of the apprentices, who had the potential to pass, deliberately failed these trade tests for fear of losing their jobs as artisans in the competitive open labour market; they wanted to remain as apprentices for good. These members thus supported a non-compulsory qualifying trade test for apprentices. It must be mentioned that the trade test comprised both a practical and theoretical aspect of which the cause of failure was mostly due to a lower score in the theory section. In Britain the average theoretical mark obtained by apprentices who took the trade test within the same time period was 40% whilst that of South Africa was 30%.[27]

[27] Pattullo, 1958:19.

Table 3.3: Trade test results from 1953 to 1956.

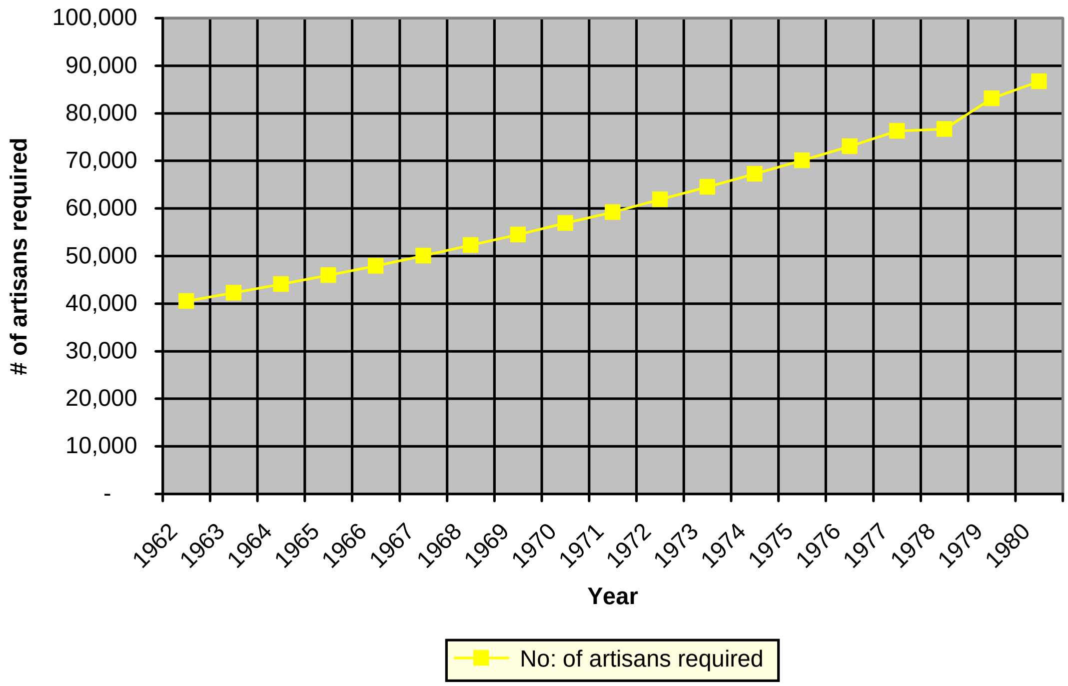
Trade	**Tested**	**Passed**	**% Passed**
Bricklaying	346	105	30
Brick-Plastering	87	18	21
Carpentry	365	83	23
Glazing and Leaded Light	8	7	87
Joiners	183	59	32
Lift Mechanic	53	26	50
Stone Mason	26	21	81
Painting	127	43	34
Plastering	73	28	38
Plumbing	324	88	28
Polishing	5	2	40
Shop fitting	75	38	51
Sign writing	11	7	64
Wall Tiling	22	14	64
Wood Machining	92	61	66
Wood working	621	182	29
Total Tested	2,418	782	**Average: 32.4**

Source: SAB, February 1957.

3.3 Shortage of Apprentices and Artisans

The current shortage of skilled labour that the South African economy is facing is not a new phenomenon. With respect to the building sector, this dates back to the early 1950's within the time frame under review. There have been many other periods in the history of South Africa when there have been severe shortages. Key amongst the factors that contributed to the shortage during that era was the 2nd World War. Again, the construction industry experienced a tremendous boom in the 1950's and 1960's and therefore there was the need for more artisans. The 1950's projection of the South Africa population indicated that the population would double by the end of the century and this therefore required building activity to double by the same margin in order to accommodate the projected increase in population. It was in this light that the NFBTE made the following estimate of artisans (skilled labour) required as shown in Figure 3.1.

Fig 3.1: Estimate of skilled labour requirement (Building Industry)



Source: SAB, January 1964.

An average intake of 2 400 new apprentices per year was projected up until the year 2000. A comparison of Figure 3.1 with Table 3.4 shows that the actual number of artisans as at 1970 (Table 3.4) was lower than what was projected for the same year (Figure 3.1). This is an indication of the severity of the skills shortage in the building industry in the 1970's. The construction sector's component of the Gross Domestic Product (GDP) within this period was on average above the 5% to 7% that the World Bank considers as the international standard.[28] In 1970 for instance, the construction sector alone accounted for 12% of the GDP.[29]

Table 3.4: Projection against actual.

Item	**1970 (Actual)**	**2000 (Projection)**
No: of skilled artisans	41,480	*262,400*
Cost of building works	R1, 7 Billion	R10, 2 Billion
Construction sector component of GDP	12%	

Within the same period, the recruitment drive for apprentices in these trades did not bear the expected results; the late 1950's saw a declining trend in the number of recruits on an annual basis. Although this trend picked up in the early to mid 1960's, it was not substantial enough to offset the backlog and make up for artisans who were also leaving the industry. The average number of apprentices indentured into the building trades in the 1950s was less than a thousand per year and that of the late 1960s averaged 1 300. As of 1958, a total of 3 468 registered apprenticeship contracts were in place.[30]

This led to what was termed artisan piracy; employers began poaching the few artisans by offering higher wages to artisans. This scenario contributed to the inflationary cost of buildings and also did not encourage many apprentices to take the trade test since jobs were readily available. To make matters worse, most of these recruits left their apprenticeship half way through it; out of the 1 317 apprentices indentured in 1955, 991 of them wrote the trade test with only 318 passing.[31]

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28 Altman & Mayer, 2003:9.
29 Moyle, 1972:57.
30 DoL, 1960:37.
31 De Klerk, 1958:19.

Apart from the fact that most of the other sector apprentices found within organisations such as S.A Breweries, Lever Brothers, and Escom, were being paid better than the building industry apprentices, the latter were of the view that the five year duration was extremely long. Contrary to the five-year apprenticeship system in South Africa and Britain, France had educational centres of apprenticeship running for only three years full time, starting at the age of 15 years.[32] Between 1957 and 1960, only 28,2 percent of candidates passed the prescribed building trade test. A careful analysis of published literature gives an indication that more emphasis was put on the five year period rather than on what should have made up the content (i.e in terms of the subject matter of the trades) of the five years. In addition, apprentices were of the opinion that their immediate superiors, who were artisans, looked down upon them as mere unskilled employees which they considered to be demeaning.[33] This development, together with some of the reasons given in the previous section, did not encourage minors to follow a career in the building trades. The lack of interest in the apprenticeship system was concentrated within the white race. They were of the view that these trades had failed to become full trades and secondly there was a high intake of coloured artisans within the industry. The employers said, as much as they preferred to employ white artisans, they were facing stiff competition from coloured artisans who were undertaking small works for their own account or from a minority of white employees. When it came to the wet trades such as bricklaying and plastering, the white apprentices considered them as heavy manual work, which was usually carried out in an appalling or unpleasant environment, which usually left them with muscular ailments in their middle age.[34] In an effort to annul this trend, the basic weekly wages of apprentices were increased substantially but this was still below other apprenticeship schemes within other sectors.

The Job Reservation Act, which favoured the white race, was re-enforced to ensure that employers adhered to it. There was even the consideration by the NFBTE of bringing on board retarded, rehabilitated and ageing persons to be trained as artisans.[35] This included

[32] Williams, 1959:19.
[33] Pattullo, 1958:15.
[34] SAB, 1960:48-49.
[35] De Klerk,1958: 23.

persons who had a defective foot or leg but could stand for a reasonable time; persons who had lost up to two fingers on both hands but still had a strong grip in their hands. Subsequently an advertising campaign was launched to this effect.

When it became clear that the NFBTE could not attract a substantial number of white apprentices and artisans, government policy then encouraged building employers to transform the conventionally labour-intensive sector into a machine-intensive one. This was also to ensure that the number of Bantu workers working within the restricted white demarcated zones was reduced to the minimum.[36]

In 1951 the Apartheid government did not consider it fit for white artisans (generally referred to as European artisans) to undertake building activities in African areas. It was a fact that the use of white artisans in the native areas was going to further reduce their availability within the urban areas. It was on this basis that the Native Building Act of 1951 was enacted by parliament.[37] This act permitted the training and registration of blacks as skilled personnel within the restricted African areas. By November 1960, a total of 2 580 Bantus (Blacks) had passed their respective trade test, with a further 1 200 under training.

The shortage of artisans is more severe presently (1990's and this new millennium) than in the past. According to Visser, (1990); 'the number of apprentices declined from 6 444 in 1972 to a mere 1 212 in 1988 and only 214 at the beginning of 1989. The total number of people who took building trade tests from 1980 to 1988 amounted to 6 357, or 708 per year, while only 2 082 or 230 per year actually passed their tests. The construction industry employed more than 400 000 people in 1988 and if only 230 qualified people are added to the industry per year the size of the skilled manpower problem becomes evident'.

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[36] SAB, 1965:9. Official opening address by the Deputy Minister of Bantu Administration and Development (Hon. M.C Botha) on the proceedings of the 60th Annual Congress of the NFBTE in Port Elizabeth.

[37] Louw, 1954: 13-15.

3.4 The National Development Fund

The NFBTE established the National Development Fund (NDF) in 1960 to cater for the needs of the industry. According to the SAB, the establishment of this fund by the building industry was the first of its kind in the world. One of the objectives for the setting up of this fund was to use the proceeds from the fund to inform prospective apprentices about the job opportunities in the industry. As one of its main first tasks, this fund with the support of the then National Institute for Personnel Research (NIPR) and the Industrial Economics Division of the CSIR, embarked on a full scale investigation to ascertain the reality of the availability and recruitment needs of skilled labour.

It became quite clear to the Management Committee of the NDF in the mid 1960's that the low patronage of apprentice and skilled labour to the Industry could be due to the attitude of employers. As a result, the committee requested the NIPR to carry out scientific research into the attitude of employers in the industry. A summary of the conclusions from the NIPR on this subject is outlined below:

1. Employers were not interested in engaging apprentices because of the poor quality of the applicants.
2. The cost of training of apprentices was too much for employers to bear. Subsidising the training had the potential to encourage employers to attract more applicants.
3. A shortening of the apprenticeship period was not going to induce the majority of employers to engage additional apprentices although the majority favoured the shortening of the apprenticeship period.
4. Employers were of the view that an increase in the wages and an improvement in the recruiting methods would result in attracting more applicants which would enable them to select the best out of the applicants.
5. The majority of employers were of the view that the apprenticeship training was outdated. They believed that an establishment of a training centre for apprentices within the building industry would ensure proper training.

6. They favoured abolishing the Job Reservation Act and thus requested opening skilled trades to all races.[38]

The failure to recruit adequate apprentices and also to curb the rate at which artisans were leaving the building trades led to a new recruitment drive which targeted artisans from European countries, especially of Dutch origin. This was followed up by an immigration campaign, which started in 1964. By means of the NDF, one staff member from the NFBTE was sent overseas in July 1967 with the objective of advertising and subsequent recruitment of 2 000 artisans and 800 apprentices. By the time the mission ended in September, only one hundred and twenty five (125) artisans were prepared to come to South Africa.[39] This trip did not target any African country. The failure to achieve the said target was attributed to the fact that the basic wage salary in South Africa did not match that of the European countries; the pension and health benefits were also a deterring factor. Between the year 1963 and 1972, records at the Department of Immigration indicated that 15 886 building trade immigrants had entered the country. Efforts by the BIFSA, formerly NFBTE, brought in an additional 891 immigrant artisans between 1970 and 1972. Together an average of 2 000 immigrant artisans entered the country annually between 1963 and 1972. The same period also saw the doubling in size of the skilled labour force.

The NFBTE responded quickly to some of the conclusions of the NIPR; proposed new conditions for the apprenticeship system were published in an extraordinary Government gazette on the 24th of November 1967. These new conditions, of which the key ones have been stated below, became enforceable on the 31st of January 1968:

- The apprenticeship duration was reduced from five to four years for all the old trades with the exception of electrical wiring. Fifth year apprentices were to be paid an artisan wage.
- Allowances were increased for individuals studying under the sponsorship of the NDF.

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[38] Pattullo, 1967: 50-5.
Vorster, 1968: 43.
[39] Zylstra, 1967:56-57.

- A block release system was introduced which required apprentices to attend technical training continuously for a duration of 10-13 weeks instead of the one day per week system.

Two new trades were introduced; 'Resilient Wall and Floor Covering' and 'Ceiling Erecting' with a two and half to three years duration. In late 1969, a two-year exemption was granted to the industry, which allowed the training of minors above 19 years as bricklayers, plasterers and carpenters under the Apprenticeship Act. This was due to the adverse shortage of apprentices in these trades.[40] In 1970, the Government opened a National Trades School in the Cape and the Baragwanath Training Centre in Soweto for white applicants who were 21 years and older. The purpose of this was to accommodate majors who might have lost their livelihood, through drought on their farms or other misfortune to learn a trade. The requirements for this training was such that the trainee had to be in possession of a Standard Six Certificate or higher, with good health. The duration of training was six months intensive with a subsequent 3 years employment with an approved employer. When a trainee (after eighteen months of employment) successfully passed the qualifying trade test, a journeyman status was immediately conferred on the trainee. Wages for this category of trainees were higher than for apprentices and lower than that of a full-time artisan; whereas the latter was earning R47 per week, a trainee in his last six months of employment was earning R35 per week. The cost of training each trainee was R 2 000 as at October 1970. A similar exemption was granted in 1971 for the training of coloured artisans as bricklayers and plasterers within certain restricted white areas. This was meant to cater for the acute shortage of white artisans in these wet trades. The conditions, which were attached to this exemption, required the employer to ensure that as practically as possible, coloured worked separately from whites and no white apprentice worked under the supervision of a coloured artisan.

[40] SAB, 1970:17.

3.5 Other reasons for the decline in apprenticeship

Research carried out by NFBTE in 1967 revealed other interesting factors that did contribute to the decline of apprenticeship. The author is certain that most of these factors that worked against the system still persist today and in some instances in a modified form. These factors ranged from social to employment conditions; some of which have already been mentioned.

Social Factors

The Federation did observe that some of the apprentices came from a poor background, which was partially due to broken homes and alcoholism. In order to support their families, they left the industry in search of greener pastures. Again, these categories of apprentices lived in an unfavourable environment and were as a result badly influenced by their colleagues or associates into drugs and alcoholism; this contributed to absenteeism. There was also the issue of parental influence in the choice of occupation and many of those apprentices who left the industry and prospective apprentices acknowledged the influence of their parents; some parents believed that it was injustice to recommend bricklaying and plastering, for instance, to a child as a career.

Racial Factors

It was further established that the perception amongst the white race was that the Building Industry was inferior to other industries and was becoming dominated by the Bantu. As such most of the prospective apprentices were not prepared to work in the same project environment with a Bantu apprentice.

Prestige

In the eyes of the public, the industry had a low image; the building trades were generally looked down upon by apprentices in other industries and this did not auger well for the industry. All the building trades were generally associated with bricklaying whereas apprentices in other industries such as the ‘fitter and turner’ were considered as engineers.

Negative Beliefs

There was the general belief that periods of artisan unemployment were associated with the building trades and as such artisans faced severe job insecurity. These artisans were also not in a financial position to start their own businesses. In this present age, experienced artisans with entrepreneurial skills who have the potential to start their own business are being stifled by the difficulty to access finance.[41] It has also been mentioned above that other industries offered better prospects, which resulted in discouraging new recruits in the building trades.

Transport

In many instances, apprentices had to find their way to work and back home without any support from the employer or NFBTE. The cost of transportation was borne by the apprentice and this was discouraging to them.

Accommodation and Tools

The purchase of tools by an apprentice was often done without adequate assistance from the employer. The apprentice had to bear the full cost of accommodation from the wages he received; this was not subsidized in any way by the employer and thus created major problems for the apprentices.[42]

[41] McCutcheon et al, 2004:14.
[42] MBA, 1967:53-55.

3.6 Trend of artisan productivity norms

There is no clear published research position on the issue of current artisan productivities relative to the past although many professionals in the construction industry believe that the present rates are lower than what prevailed in the past. The lack of clarity on this issue stems from the fact that productivity norms established in the early 1950s have not been methodically reviewed on a frequent basis. Changes in work methods and design complexities require an update on productivity norms. Unfortunately, BIFSA and related national institutions have not been continuously up to date on this. Thus, what could be considered a fair day's work on a construction site varies from one firm to another. Figures quoted by such firms as representative of baseline productivity have been generally deduced from averages attained on previous actual outputs of similar projects. These baseline figures thus incorporate all the inefficiencies of both management and the work force.

3.6.1 Productivity norms established from the Vereeniging Work Study

One of the highly acclaimed time studies carried out in the building industry by the National Building Research Institute in the early 1950's, took place at Vereeniging, which is located in the southern part of the Gauteng Province. The aim of this study was to establish the skilled-hours required of an average South African artisan (Bricklayer) of a white race to erect the walling of three different groups of ten typical native houses each (i.e. 30 houses in all) with the wall specifications as follows:

I. 9 inches (228,6mm) solid external brick walling, 4,5 inches (114,3mm) internal walling;
II. 9 inches brick on edge cavity external walling, 3 inches (76,2mm) brick on edge internal walling;
III. 4,5 inches brick plastered external walling, 3 inches brick on edge internal walling.

Concurrently, unskilled labour was also employed on the same site to erect the above walling. This was to allow for the comparison of man-hours used. Table 3.5 shows the results obtained from the time study carried out; no time adjustment has been made to cater for avoidable delays.

Table 3.5: Brickwork times for the construction of the NE 51/9 type Native house from floor level upwards.

Operations	9" solid walling		9" brick on edge cavity walling		Plastered 4,5" walling	
	Hrs Skilled	Hrs Unskilled	Hrs Skilled	Hrs Unskilled	Hrs Skilled	Hrs Unskilled
Brickwork to window sill height	41.750	60.600	**33.240**	**51.800**	37.695	57.372
Brickwork to wall plate height	48.767	81.400	**40.500**	**62.500**	47.878	75.162
Brickwork to Gables	24.067	41.000	18.340	26.280	**16.260**	**24.726**
TOTAL	**114.58**	**183.000**	**92.180**	**141.120**	**101.89**	**157.260**
DILUTION OF LABOUR	1	1.598	1	1.531	1	1.551

Source: SAB, January 1953.

The time taken for plastering is included in the figures for the 4,5 inches plastered walling in Table 3.5. It can also be seen in this table that brickwork is more time consuming when erecting from the sill height to the wall plate height because of the additional labour for constructing window reveals. The ratio of skilled to unskilled labour was not constant throughout for all the three different groups of houses because the construction did not have the full complement of the labour force on a daily basis throughout this period. This study, which was based on an eight-hour day, revealed that the average daily output of the artisan per house was as follows:

- For the 9 inches solid walling, seven hundred face brick per day were erected;
- 4,5 inches walling plastered (stock brick), six hundred and thirty bricks per day were erected;
- 9 inches brick on edge cavity walling, six hundred bricks per day were erected;
- Twenty square yards (16,7 square metres) of plastering was effected everyday.

The above information gives an apparent indication that it was quicker to lay face brick than stock brick, but when the time spent plastering these stock brick is converted into time spent laying stock brick, it becomes clearer that approximately twice the number of stock brick could have been installed per day. This in simple terms is due to the fact that the stocks bricklayer apart from laying the 630 bricks also plasters 20 square yards in the same day. This could have amounted to a daily output of 40 square yards of plastering if the artisan constructed no stock brick.

It must be noted that the above productivities deduced from this study cannot be considered as optimum productivities since it was not adjusted to cater for idleness/avoidable delays. Table 3.5 does not give in-depth details of what the crew size for the brickwork was. Thus these productivities based on only one artisan are quite deceptive; the composition of the number of artisan(s) to that of helper(s) that constitute a crew/gang size for a particular task is crucial in establishing baseline norms. For example, two different crews having the same number of workers and working under the same conditions will not produce the same output if the composition of artisan to helper ratio is not the same for both groups. Irrespective of these lapses, these daily output figures were set up as the artisan productivities norms by NFBTE for all building works within the country. The NFBTE thus asked all contractors to at least equal these productivity figures.[43]

3.6.2 Subsequent productivity norms

The shortage of artisans during the 1950's and 1960's actually did not affect artisan productivity. Most of the artisans did surpass the productivity rates earmarked by the NFBTE. In the late 1960's for instance, it was common knowledge for a prospective artisan of a contracting firm to demonstrate that he had the potential to erect a minimum of 1 000 face bricks before he was guaranteed employment. Some published research has attributed the high rate of productivity during that era to the four to five years duration of apprenticeship.

The construction industry currently has a situation whereby many of the so-called "artisans" found working on construction sites do not have accredited certificates. They have learnt the trade informally, on site. The quality of work and hence the level of daily outputs to a large extent, confirms the level of training received by this class of workforce. According to Project Home, the average daily output based on a crew size of one artisan and a helper as shown in Table 3.6 are the current productivity norms in South Africa.

[43] Louw, 1954:13-15.

Table 3.6: Estimated current baseline productivity norms in South Africa's building industry.

Activity	**Crew Size**	**Average daily output**
Face brick	1-bricklayer, 1-Helper	800-1 000
Standard Plastering	1-Plasterer, 1-Helper	8-12 square metres
Brush Plastering	1-Plasterer, 1-Helper	30 square metres
Painting	1-Painter, 1-Helper	45-50 square metres
Roofing	1-Roofer, 1-Helper	500 tiles
Brick Paving	1-bricklayer, 1-Helper	30 square metres
Tiling	1-Tiler, 1-Helper	30 square metres

Source: Project Home, 2006.

3.7 Classification of Artisans

Currently, there are three categories of artisans that can be found within the South African building industry. These categories are as follows:

1. In the majority, are the so-called 'artisan' who lack the basic technical skills required of the trade they are engaged in. This class of artisans mostly learnt the trade through the informal way.
2. The second category of artisans has the required basic technical skills but lack experience.
3. The third category belongs to artisans with the required technical skills and experience. These artisans are mostly the apartheid artisans who had the opportunity to go through the four to five year apprenticeship system. Unfortunately, they are near extinction within the industry.

3.8 Conclusion

The objective of the NFBTE to have a nationally controlled plan for the apprenticeship system, took over 30 years before it was achieved in 1956. This ensured that all the local committees of the NFBTE conformed to one centrally controlled scheme and thus resulted in uniformity in the number of years for apprenticeship, salary wages and the type of designated trade for the whole country. The economic boom in the 1950's and 1960's did not attract the required number of apprentices and artisans that were needed to execute building projects.

Several factors contributed to the low intake of apprentices and artisans during that era; some of these factors were focused on the poor remuneration when compared to other sectors. Other factors were racial in nature, and the poor perception or image the building industry had in the eyes of the general public. Although the productivity rates of the apartheid artisan was quite encouraging, the inability to attract them on a mass scale was more due to managerial problems on a national level than due to skills inadequacies of the artisans. The attitude of employers towards apprentices was also a contributing factor. The findings of the NIPR and consequent introduction of the national development fund did go a long way to attracting prospective apprentices. The fund also enabled the NFBTE to embark on a recruitment drive in other European countries although this did not yield substantial results.

CHAPTER 4: Artisan productivity trends on the International scene

4.1 Introduction

Artisan productivity rates in the United States of America have been higher than most of the European countries since the 1950's. Technological change and improvement in work methods have contributed to the increase in artisan productivity. In Europe different methods of wall construction using bricks do exist.

Section Two of this chapter looks at baseline artisan productivity in the USA and the UK and outlines the efforts the UK made to replicate the success story of the USA. In Section Three, the different methods of wall construction with their associated productivity rates in the UK are described. Section Four describes two major work-studies in the UK and France and compares the man-hours used during the building activities. The major factors affecting bricklaying productivity are also considered in this section. Section Five describes some key techniques that were employed in the UK to improve bricklaying productivity whereas Section Six outlines some of the technical and managerial requirements of bricklaying. Section Seven is the conclusion of this chapter and thus highlights the key results.

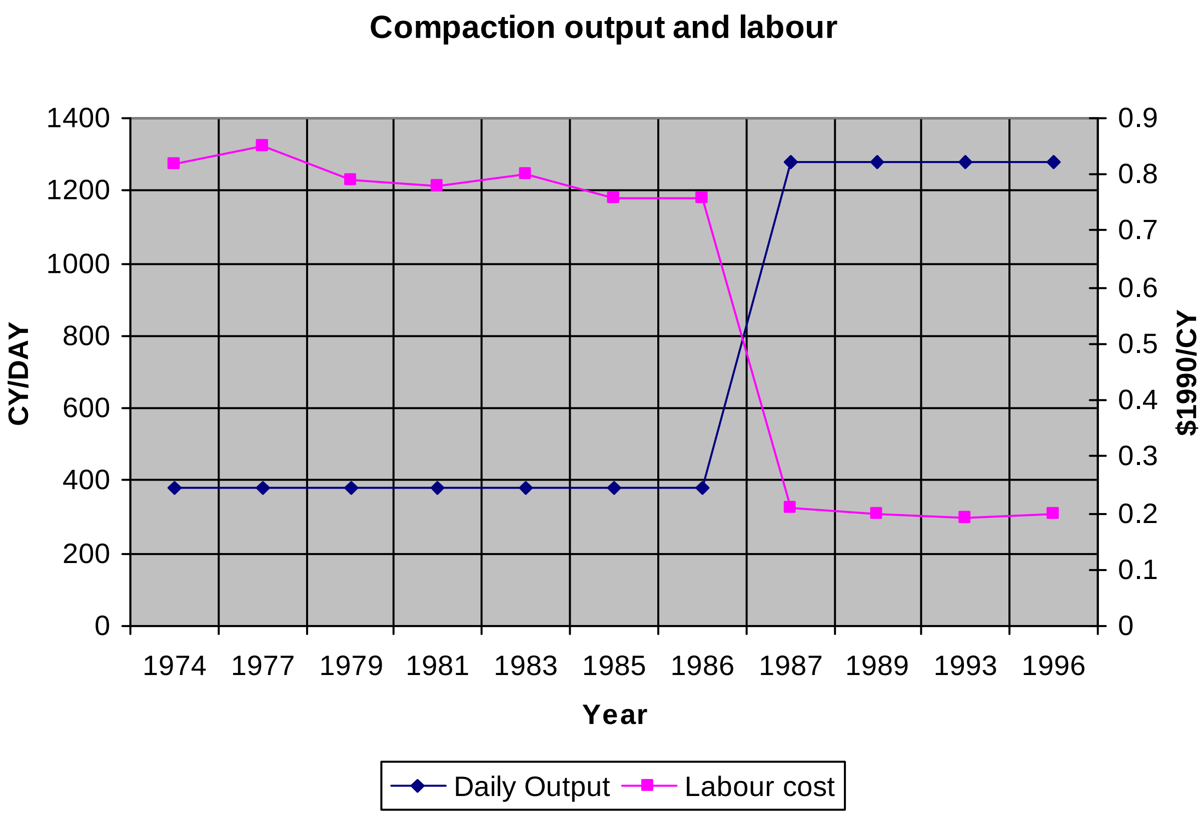
4.2 Productivity trends in Europe and America

The United States of America (USA) stands out prominently amongst the majority of the industrialized countries with a history of outstanding artisan productivity rates. This is one country that is continuously reviewing productivity norms on an annual basis. According to Haas et al (1999), the USA construction labour productivity has generally been on the increase since the early 1950s. In instances where there has been no increase, it has remained constant. Haas et al, attribute the increasing trend of labour productivity and for that matter, artisan productivity, to the constantly improving work methods; many of the simple tools previously used on construction sites have consistently become more machine-intensive (i.e. power driven). This has resulted in labour requiring less effort to execute a task at a faster rate. As much as this bias towards machine-intensive technology is detrimental to employment-intensive creation, it negatively affected labour wages in the USA. This is because labour wages to some extent, were invested in the acquisition of equipment. Figures 4.1 to 4.3 depict the labour productivity trend of some construction tasks. The productivity is measured in cubic yards (CY) per day whereas all the labour wages have been converted to the equivalent figures of the year 1990. It can be seen in Fig 4.1 that there was 260% increase in productivity between 1986 and 1987 with a concurrent 75% decrease in unit labour cost. The sheepsfoot roller compactor with 8" lifts had been in used between 1974 and 1986 but was subsequently modified by the addition of vibration to the rolling action of the compactor in 1987. Fig 4.2 demonstrates the influence of the technological improvement of the sheepsfoot roller on equipment cost. According to Haas et al (1997), 'although the equipment change led to a 40% increase in daily equipment costs, it also led to a 60% decrease in unit equipment costs.'

The capital cost involved in the acquisition of new technology, demonstrates why contractors are sometimes hesitant in the acquisition of new and advanced equipment. The acquisition pays off in the long term since the operational/unit equipment cost is decreased. In summary, a new and improved technology can lead to an increased labour productivity at a lower labour and unit equipment costs. In Fig 4.3, Hand Trenching daily output remained constant whereas unit labour cost gently declined throughout the same period. [44]

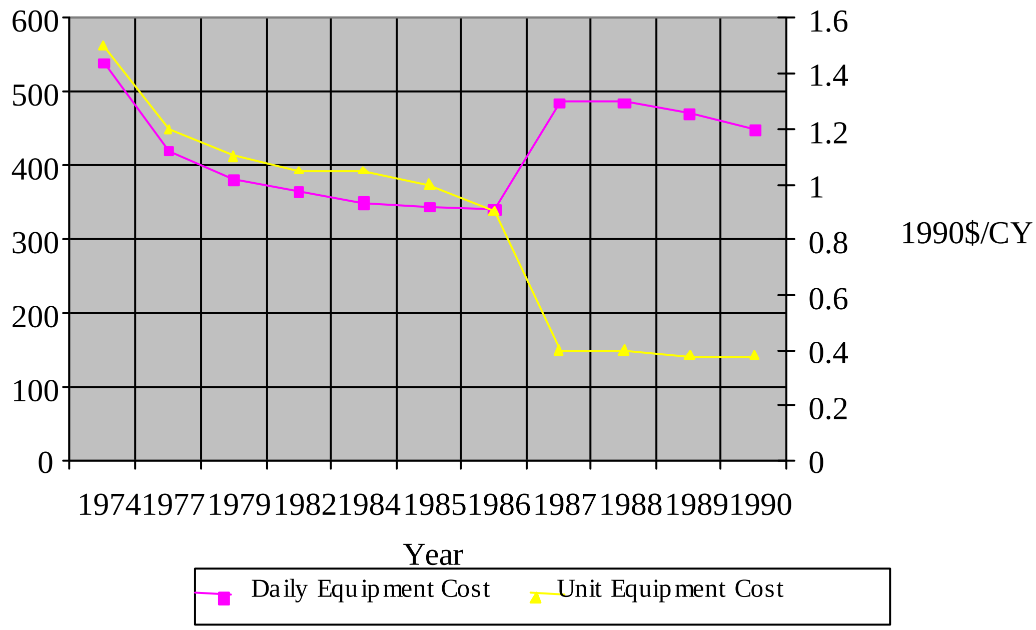
[44] The report of Haas et al does not indicate whether any new equipment was introduced during the period that the Hand Trenching daily output remained constant.

Fig 4.1: Compaction productivity in Heavy Construction.



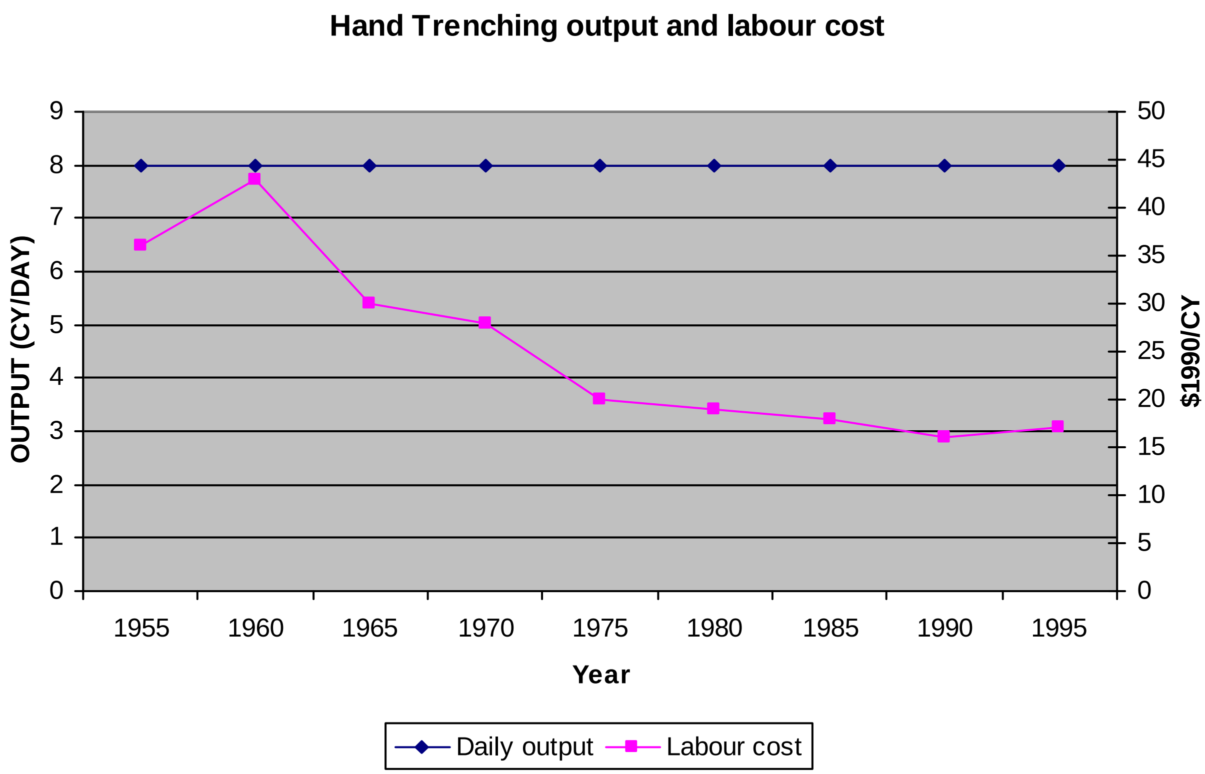
Source: Haas et al, 1997: 13.

Fig 4.2: Unit and Daily equipment cost for compaction



Source: Haas et al, 1997: 14.

Fig 4.3: Hand trenching output and labour cost.



Source: Haas et al, 1997: 15.

In the United States, productivities norms have been reviewed and published on an annual basis since 1942.[45] Most contractors in the United States rely on these figures in the estimation of project duration and preparation of their bill of quantities. 'Means' is a product line of Reed Construction Data Incorporated, a leading provider of construction information, products, and services in North America and globally. According to the Means publications, these norms were achieved by averaging the productivity figures obtained from the previous years from over 30 trade unions within the building industry in the United States.[46] Figures from the trade unions were also obtained through direct field observation of on-going construction works and also through the support of

[45] Means, 2006:2.
[46] Ibid.

consultants working directly on these sites. The productivity figures shown in Table 4.1 below represent the daily outputs for the current year 2006, which was extracted from the Means 2006 publication. The author of this report has converted these figures to the metric system. The corresponding labour rates are as indicated in Table 4.2.

INSERT

Table 4.1: 2006 Artisan productivity norms in the U.S.A

Table 4.2: 2006 Labour cost of some building trades in the U.S.A.

Trade	Basic hourly rate ($)
Bricklayer	36.55
Bricklayer Helper	27.75
Painters, Ordinary	31.70
Plasterer	32.45
Plasterer helper	27.90
Roofer, tile & slate	30.60
Roofer, Helper	22.55
Tile layer	34.25
Tile layer, helper	26.50

Source: Means, 2006: Back of cover page.

From Table 4.2, it is observed that whereas amongst the artisans, the bricklayer is the highest paid per hour, the plasterer-helper is the highest paid amongst the helpers. A bricklayer irrespective of laying either face brick or stock brick earns the same amount per hour. This payment system for bricklayers is also observed in most European countries. In 1949, the basic hourly rate for a bricklayer in the United States was $ 3.50, which far exceeded what his colleague in the United Kingdom or South Africa earned. During that era, the two years gross salary of a bricklayer in the United State could purchase the lowest priced house worth 2 000 pounds whereas his counterpart in the United Kingdom required five and half years to purchase the same house worth 1 800 pounds in the United Kingdom.[47] This was because labour productivity rates were relatively higher in the U.S than in the U.K and as such yielded a higher production in terms of buildings constructed in a given time.

[47] NFBTE, 1955:15.

It must be mentioned that the U.S did not have any incentive scheme in place during that era. The U.K realising their poor productivity rates, visited the U.S to ascertain what could be done to improve upon their artisan productivities. After the official visit by the British Productivity team to the U.S in the summer of 1949, an incentive scheme was introduced in the U.K building industry in the early 1950's to motivate labour to improve productivity; the South African building industry followed suit with a similar incentive scheme. After their visit, the U.K team concluded that the poor labour productivity was mainly due to lack of managerial and procurement efficiency. The team observed that in the U.S before the construction of any building, a well detailed plan, drawings, designs and specifications were in place and this was not the case in the U.K; the client in the U.K never had a thorough picture of exactly how the building would look until it was complete. Thus the building plan was only ready after the building was complete. This was due to lack of adequate pre-planning on the side of the architect and project management team. Today this trend has changed in the U.K and many other countries.

4.3 Methods of Wall Construction

Bricklaying is one out of many building activities that has undergone numerous productivity studies. In Europe, different methods of bricklaying and for that matter wall construction evolved during the early 1950's. Scaffolds also came in different dimensions. In Austria, whereas the shutters (runway) of the scaffolds were 5ft, 4 inches in length those of Russia were 8ft and divided into three zones, with the 1st zone, 2ft wide serving as the working zone. The 2^{nd} zone, which was also 2ft wide, was used for circulation and transport whereas the last 4ft was used for stacking materials. The scaffolding system in Denmark was erected in such a way that a 16-inch wide board at a height of 4ft. 4in. runs the whole length of the scaffold and the bricklayer-helper stacked the bricks for the bricklayer. This system was such that the bricklayer did not have to stoop at any given time to pick up bricks.[48]

[48] Rosner, 1956:23-31.

In Austria, the common hand tool used for bricklaying during that era was called the 'pan'. The pan looked more like a shovel with a mortar capacity of 1,5litres, which could lay a mortar bed for 6 to 8 bricks in one run. The bricklayer then held two bricks concurrently with both hands and pressed them diagonally into position so that the mortar squeezed into the vertical joints. Although the Russians and the Polish used the panning system for laying the mortar bed, the method of positioning the bricks in place differed slightly; the helper was responsible for spreading the mortar and stacking bricks. Thereafter the bricklayer employed one of two laying techniques. Depending upon the experience of the bricklayer, one or two bricks are held at an angle to the mortar bed and pushed slightly against the mortar bed in such a way that the lowest edge scoops up the bedding mortar over a distance of 2 to 3 inches. The scooped mortar fills the vertical joint between these bricks. The conventional method employs the use of the trowel to scoop mortar against the brick laid last and the next brick is pressed vertically into position. Where there is surplus joint mortar, it is removed. When the mortar joint is insufficient, additional mortar is pressed into the joint using the trowel. Table 4.3 shows the level of productivity increase obtained after some of these improved methods were introduced in some European countries. In the then East Germany, 75% productivity improvement was achieved.

Table 4.3: Productivity norms in some European countries.

Country	**Hand Tool**	**Daily Output/ (# of face bricks)**	**Daily Output after improved methods**
Russia	Pan/Trowel		1,600-1,900 per head
E. Germany	Pan	850 per head	1,500 per head
Austria	Pan		
U.K[49]	Trowel	1000 per head	1,250

Source: Rosner, 1956: 23.

[49] BAS, 1956: 42.

4.4 Productivity and cost of labour in bricklaying

In the Norwich city of the United Kingdom, a work study which was very similar to the Vereeniging study in South Africa (see section 3.7), was carried out between September 1952 and February 1953 on the construction of 32 houses. These houses had the same design and each house consisted of approximately 17 500 bricks. Prior to the start of the construction, it was estimated that each bricklayer could lay 350 bricks per day but by the end of the project the daily average output was 380 bricks. The low output according to the study was due to the physical constraints imposed by the needs of scaffolding and the over congestion of the number of bricklayers employed on the scaffold. Table 4.4 is a summary of the average man-hours spent in constructing the superstructure of each of these houses. The percentage time composition of the various activities in this table is also an indication of the work demands required of each activity. It is clear from this table that brickwork is more time consuming than any of the activities whereas roof tiling is the least time consuming and this trend is reflected in the labour wage structure as depicted in Table 4.2; the bricklayer and roofer were the highest and lowest paid respectively in Table 4.2. The difference between the brickwork man-hours used in Tables 3.5 and 4.4 could also be attributed to the difference in design complexity.

Table 4.4: Man-hours per House in Production Run (Norwich city)

Activities	**Programmed Man-hours**	**Actual Man-hours**	**% Actual Man-hours**
Brickwork	620	568	45
Carpentry	237	164	13
Roof tiling	39	32	3
Plastering	160	225	18
Painting & glazing	160	180	14
Plumbing	121	87	7

Source: SAB, May 1954.

Table 4.4 exhibits results similar to Table 4.5. Figures from Table 4.5 were attained from a work study in France during the same period. The design of the houses was very similar to those found in Norwich city.

Table 4.5: Man-hours per House in Production Run (France)

Activities	**% Actual Man-hours**
Brickwork	36
Carpentry & glazing	16
Roof tiling	4
Plastering	31
Painting	5
Plumbing	8

Source: SAB, May 1954.

These work-studies revealed that the factors that can affect the speed of brickwork were dependent on:

- The complexity of the work;
- Available labour force (i.e. the number of people executing a given task);
- The productivity of the bricklayer;
- The physical limitation imposed by the needs of scaffolding;
- The number of bricklayers that can economically be employed on the scaffold.

4.5 Improving work method

The United Kingdom NFBTE of the 1950s had in place a Building Advisory Service (BAS), which was tasked to assist building firms on a daily basis in overcoming some of the problems they encountered frequently on site. In one such encounter on a bricklaying site in 1956, the BAS made the following observations, which were published in the BAS Casebooks Three and four:

- The average daily output of the bricklayer was 1000 bricks per head.
- On average, the bricklayer was taking 3 seconds to stoop to pick up each brick. This amounted to 50 minutes stooping to pick up bricks everyday.
- The bricklayer was continuously bending and stretching to reach mortar.
- The scaffold was moving up at an interval of 4ft, 6inches.
- The bricklayer complained of severe backache after each days work.

The following improved working methods were introduced by the BAS on the site after the above observations were made:

- A shelf was attached to the scaffold and the bricks were placed on shelves instead of the platform of the scaffold (shutters). This was meant to reduce the time spent by the bricklayer stooping to pick up bricks.
- The interval at which the scaffold was moving upwards was halved to ensure that the bricklaying was working at nose level most of the time; thus reducing bending during bricklaying.

These interventions resulted in the bricklayers daily output increasing to 1 250 bricks per day; i.e. an increment of twenty percent.[50]

4.6 Technical and managerial requirements of bricklaying

In bricklaying, a bricklayer with a sound technological know-how must not only have the ability to demonstrate how to carry out the bricklaying operation; he/she must understand why it is constructed in a certain way. With regards to the demonstration ability, John Hodge who is the author of "Brickwork for apprentices" states that a good bricklayer:[51]

- Must master the ability to spread the mortar bed in an artistic manner;
- Must pick up the mortar with an easy sweeping motion and spread it on a wall sufficiently thick so that the brick can be place by the pressure of the hand;
- Must show dexterity in the handling of the bricks to be laid;
- Must possess a keen eye;
- Must be able to estimate the amount of mortar bed required by the feel of the brick;
- Does not clench the fist whilst grasping the trowel but rather he/she places the thumb on the ferrule and handle lightly. This allows for flexible fist action;

[50] Ibid.
[51] Hodge, 1993:90.

The work layout of brickwork should be such that there is no unnecessary movement. This requires that management ensures that materials such as bricks, mortar, and the spot boards which holds the mortar are conveniently placed and within the reach of the bricklayer. With regards to the right use of the spirit level, it is required of the bricklayer to crosscheck the horizontality of a brick course by reversing the spirit-level end-for-end. If the brick course is horizontal only in one direction, then it is an indication that the clamping screws of the horizontal bubble tube of the spirit-level needs to be adjusted. A similar test must be done to check the plumbing bubble.[52]

The essence of the mortar as a bricklaying material is to ensure that overlying bricks rest firmly on the underlying bricks. In this regard, it is the duty of management to ensure that the constituent materials are supplied in adequate quantities whilst the bricklayer must also ensure that the mortar composition is in the right mix. The right composition of the mortar will ensure that mortar sticks firmly to bricks in external walling in order to keep rain out and at the same time keep bricks apart so that the brick courses are kept apart. The rule of thumb is to ensure that the compressive strength of the mortar is slightly lower than that of the bricks. This is done to ensure that any differential settlement that results in cracks are felt in the mortar joints rather than in the bricks since it is easier and less expensive to repair the cracks in the former rather than in the latter.

In terms of mass, the bulk of the mortar must be made of sand. The composition of the mortar must be such that the sand component must be graded with a large percentage being fine grain sand. This is because the total surface area of fine sand is greater than an equal amount of coarser sand and hence has a higher ability to retain mixing water.[53] In addition, fine sand guarantees a neater and smoother joint finish than graded sand. The graded sand is required to enable the mortar to achieve the maximum density. It is technically right for the graded sand to be washed of all mud and silt in order to ensure the cement component of the mortar sticks firmly to the sand grains. Ordinary Portland Cement is the most recommended type of cement for bricklaying mortar. It serves as a

[52] Ibid 25, 28.
[53] Ibid 15.

binding agent for the sand when water is added. The chemical reaction that takes place immediately water is added to the mixture, allows for the setting and hardening process to be initiated. It is acknowledge by many researchers who have studied the behavior of mortar that the lack of a plasticizer or lime in the mortar mix of water, sand, and cement, does not make it sufficiently 'fatty' or easily workable with a trowel. According to Hodge (1993), "such mortar is described as 'short' or 'harsh' and does not hold together when rolled on the spot board."[54] The generally recommended ratio by volume of lime, cement and sand is 1:1:6. It is also a requirement that clean water is used for the mixing so as to ensure that impurities do not delay or prevent the setting and hardening process of the mortar.

It is a common practice in the UK and USA that weathered bricks are made wet prior to its usage during hot summers. Apart from the fact that this procedure removes surplus dust from bricks, it also prevents undue adsorption of moisture from the mortar bed. Unlike in summer, in winter the brickwork is protected overnight against frost by the covering of the last brick course laid with sacks after the days work.

4.7 Conclusion

Whereas artisan productivity has been on the increase since the 1950's in the USA, its associated labour wages have been on the decline. It has also been demonstrated that an improvement in design complexity does contribute to an increment in productivity; the European countries managed to improve upon bricklaying productivity by improving upon the work methods, whilst the USA focused on improving upon the working tools of the artisans.

[54] Ibid 16.

CHAPTER 5: Case studies of Artisan productivities in South Africa

5.1 Introduction

Chapter Five focuses on the field results obtained from two case studies carried out by the author. It describes the nature and extent of the field activities that were pursued on the two construction sites. The description unveils the author's capacity in handling concurrent activities, which were on-going. The five different building activities, which were executed by thirteen different Task Groups, are described in this chapter. Mention is also made of the two project portfolios, work methodology and the respective construction site layout.

There are six sections in this chapter; whilst Section Two focuses on the scope of the field work carried out, Section Three concentrates on the project description of the two construction sites, which served as the two case studies. In Section Four, the method which the author used for the observation of the building activities is described. Section Five presents the field results in tabular form based on each building activity. A display of the choice of formulas used in calculating potential productivities is included in this section. Section Six contains the conclusion on this chapter.

5.2 Scope and limitation of fieldwork

In order to ascertain the current productivity rates of artisans in the building industry, the author of this report embarked on a field study from the 14th of July 2006 to the 28th of July 2006. Considering the fact that the author executed the fieldwork above, there was a limit to the number of building activities that were studied. There was also a limit to the number of different Task Groups that were observed concurrently per day by the author.

The determination of the size and composition of a Task Group was outside the control of the author. The author did not impose his views with regards to the work methodology and pace of work on the workers. The motive for restricting the number of activities and Task Groups was to ensure that the author did not over work and hence remained productive throughout the duration of the field study. The author did not carry out the fieldwork during weekends even though some of the building activities were carried out during the weekends.

Fifty five observations were carried out on the five different activities. Each observation spans the duration of a working day. What this meant was that a particular Task Group's activity was observed only once in a day. As has been mentioned above, different task-groups carrying out either similar or different building activities were observed concurrently in most instances on the same day. This was pursued because of the proximity of the site locations and, as such, it was possible for the author to observe these activities clearly and concurrently for the greater part of the day. Table 5.1 below is a breakdown of the building activities observed, the number of Task Groups involved and the number of observations for each Task Group. The fieldwork focused on construction sites erecting commercial buildings, which were non-residential buildings.

5.3 Project description

The fieldwork took place on two different construction sites. Both sites were situated in Johannesburg and were mutually exclusive sites in terms of the labour force, client, consultant, main and sub contractors. The only building activity that was observed on both construction sites was Painting. For the purpose of this report, the project description is subdivided into two to suit the two projects; henceforth referred to as Project A and Project B. As per the conditions of contract, Projects A & B were required to be completed by the end of August 2006.

Table 5.1: Scope of Fieldwork.

ACTIVITIES	NUMBER OF TASK GROUPS	NUMBER OF OBSERVATIONS
STOCK BRICKWORK	3	12
FACE BRICKWORK	2	7
PLASTERING	2	12
TILING	4	16
PAINTING	2	8

5.3.1 Project A

Portfolio of Project A

This project involves the construction of a new shopping centre at the West Rand Crossing. It is located exactly at the corner of Hendrik Potgieter and Nic Diedrichs Blvd. The project at the time of award was worth R 94 100 000 (ninety four million, one hundred thousand rands) with a contract duration of ten months. The execution of this project began in December 2006. The key project players involved in the execution of this project were:

- Main Contractor: G. Liviero & Son (Pty) Ltd
- Client: City Square Trading 43 (Pty) Ltd
- Agent: AMA Architects
- Quantity Surveyor: O. Mahoney Peel Rowney
- Engineer: BSM Baker

Multiple Subcontracting

The main contractor sub-contracted some aspects of the work to several other contractors. All the building activities that were required for the construction of the superstructure had the labour component subcontracted. In the case of the brickwork for example, the main contractor was paying the subcontractor R 500 for every thousand bricks erected from ground level. This increased to R 800 as the brick wall was elevated in height[55]. The subcontractor was required to provide the simple tools needed for the wall construction and this was the general outlook for all the other activities which were subcontracted. Thus, all the material cost was the responsibility of the main contractor. In the author's subsequent interaction with some other senior personnel from established companies such at Wilson Bayley Homes Ovcon (WBHO) and Grinaker in the month of October 2006, it was revealed that the outsourcing of the labour component was primarily as a result of the conditions surrounding the labour laws of South Africa, which renders the labour environment very volatile. In their view, it was reasonable to outsource it in order not to get entangled with numerous labour litigations which had the potential to derail their progress of work. In effect, the main contractors do transfer this responsibility to the subcontractor who in many instances is a small contractor.

According to a report prepared for The National Labour and Economic Development Institute (NALEDI[56]) by McCutcheon et al (2003), profitability is one significant factor that drives established contractors to outsource the labour component of construction work to subcontractors/small contractors. The power of these established contractors to subcontract, has been derived from demanding inputs they have made into the procurement act which governs the conditions of tender.[57] Due to the fact that the Labour Relations Act (LRA) is more favourable to the labour force than to employees, established contractors have neutralized this advantage to some extent by transferring all the construction risks, such as the occupational health hazards that accidentally occur on

[55] Personal communication with the senior foreman of the main contractor.

[56] Naledi was formed in 1993 and it is an initiative of the Congress of South African Trade Unions (COSATU).

[57] McCutcheon et al, 2004:55.

construction sites, and social benefits that accrue to the labour force as a result of the LRA to the small/sub contractor who is not adequately positioned to absorb these risks.[58]

Building Activities and Task Groups

The main activities studied were stock brickwork, plastering and painting. It must be mentioned that the number of Task Groups for each of these activities on the entire construction site far exceeded what is reported in Table 5.1. The productivity of three, two and one different Task Groups of bricklayers, plasterers and painters respectively were observed. Each crew size or Task Group consisted of artisan(s) and artisan-helper(s). The average size of the bricklaying and plastering team was twelve with an average composition of artisan to helper ratio of 1:1.4. The average size of the painting crew was composed of two painters; there were no helpers.

Work layout and methodology

Figure 5.1 below is the Southeast view of the shopping centre under construction during the first fortnight of July 2006. The two plastering crews plastered all the walls on the first floor of Figure 5.1; Task Group A plastered the exterior walls whilst Task Group B plastered the interior walls (see appendix D for details of all the Task Groups). Task Group D constructed a greater part of the brickwork on the first floor of Figure 5.1. The other two bricklaying crews worked 70m and 150m southeast of Task Group D. The painting crew painted only the interior walls of the first floor.

With respect to the brickwork, there was a separate team that was responsible for the mixing of the water, sand and cement to form the mortar. This team was solely responsible for preparing the mortar that was used by all the brickwork crews on the construction site. The mortar crew was centrally located at ground level and was approximately 200m further away from Task Group D. The distribution of the mortar to the bricklaying sites was required to be done machine intensively but there were many

[58] Ibid 24.

Fig 5.1: Southeast view of shopping centre under construction.

Source: www.livierobuilding.com, 15th August, 2006

instances where the helpers had to use wheelbarrows to fetch the mortar and transport it to the working site. This was because there was only one front-end Loader distributing the mortar to over 10 bricklaying crews on the site. The stock brick were also centrally located near the mortar team and its transportation to the bricklaying sites was also done machine-intensively. Again, the bricklaying-helpers were called to transport them by wheelbarrows when delays set in. Transportation of these materials to the first floor was not as smooth as one would have thought since the equipment transporting the materials was obstructed by either earthworks or other building activities.

The main role of the bricklayer-helpers was to hoist the mortar and bricks onto the working platform/shutters on which the bricklayers stood. With the hoisting of the mortar, these helpers arranged themselves from the floor level and on intermediate positions on the scaffold platforms. The helpers on the floor level used their shovels to throw the mortar upwards on a shutter. Another helper standing on this intermediate shutter also shoveled the mortar and threw it up unto a higher intermediate shutter. This process was repeated continuously until the mortar reached the shutter on which the bricklayer stood. A similar approach was used for the hoisting of the bricks; a helper close to the bricks at floor level picked up two bricks at a time and threw them upwards to a colleague on the shutters of the scaffold. The colleague threw them to another colleague further up the scaffold and the process continued until it reached the bricklayer who arranged the bricks on the shutters on which he stood. It must be mentioned that the height of the wall as seen in Figure 5.1 is eleven metres from floor level; the higher the wall, the greater the number of helpers required in hoisting bricks and mortar, and the more the complex nature and amount of scaffolding needed to ensure that the bricklayer received the materials.

The bricklayers used the conventional method of bricklaying, which required the use of hand trowels in constructing the walls. The bricklayers (popularly referred to in the U.K as “brickies”), used their fish line and spirit levels to guide them to ensure that the walls they were constructing were plumb and that the horizontal layers of the brickwork were truly horizontal and clearly demarcated. With the use of the hand trowel, the bricklayers prepared a mortar bed for two to three bricks and the bricks were placed firmly in the mortar, one against the other. The vertical joints were then filled with mortar and the process repeated. This approach to bricklaying was the most common method observed throughout the author’s stay on the construction site.

The plastering team employed the same approach as the bricklaying team did in hoisting mortar to the plasterers. The preparation of the mortar for plastering was not centrally located as was the case in the bricklaying; the helpers on each plastering team prepared the mortar very close (about 6m from the working wall) to the working surface. The sand and cement were transported to the working surface machine intensively. Access to water for the preparation of the mortar was through a water hose connected to a standpipe erected about 350 metres away from where the plasterers were working. The plasterers received the mortar with their hand hawk in one hand and used their hand trowel in the other hand to scoop the mortar and either threw it or smeared it on the surface of the wall;

in most instances, it was more of the former than the latter. After a sizeable amount of the wall surface was covered with mortar, a straight edge hand tool (scraper) was used to level the surface of the wall. The process of floating followed thereafter to ensure that the wall surface was smooth.

The painting procedure was simpler. The paints used were already pre-mixed and did not require any additional work. Tight corners of the wall were painted with a brush because the rollers could not reach those tight corners. The exposed part of the walls were painted using a roller with an average arms length of between 1,5 to 2 metres.

A different crew handled the erection of the scaffolds for the brickwork and plastering. It was not the responsibility of either the brickwork or plastering crew; rather the movement or arrangement of the platforms on the scaffold was their responsibility since they could place them at the best position to make their work comfortable. The scaffolding was done first and this was followed BY the brickwork; the plastering then followed; and finally the painting.

5.3.2 Project B

Portfolio of Project B

The project involved the construction of an Office Block and a retail centre. It is located within the vicinity of Featherbrooke Estate in the West Rand of Johannesburg. According to the foreman on this site, the project was worth R 20 000 000 (twenty million rands). The key project players involved in the execution of the project were:

- Main Contractor: G.I.P Builders (Pty) Ltd
- Client: Featherbrooke Development Agency

Subcontractors were also employed on this project to carry out some aspects of the contract.

Building Activities and Task Groups

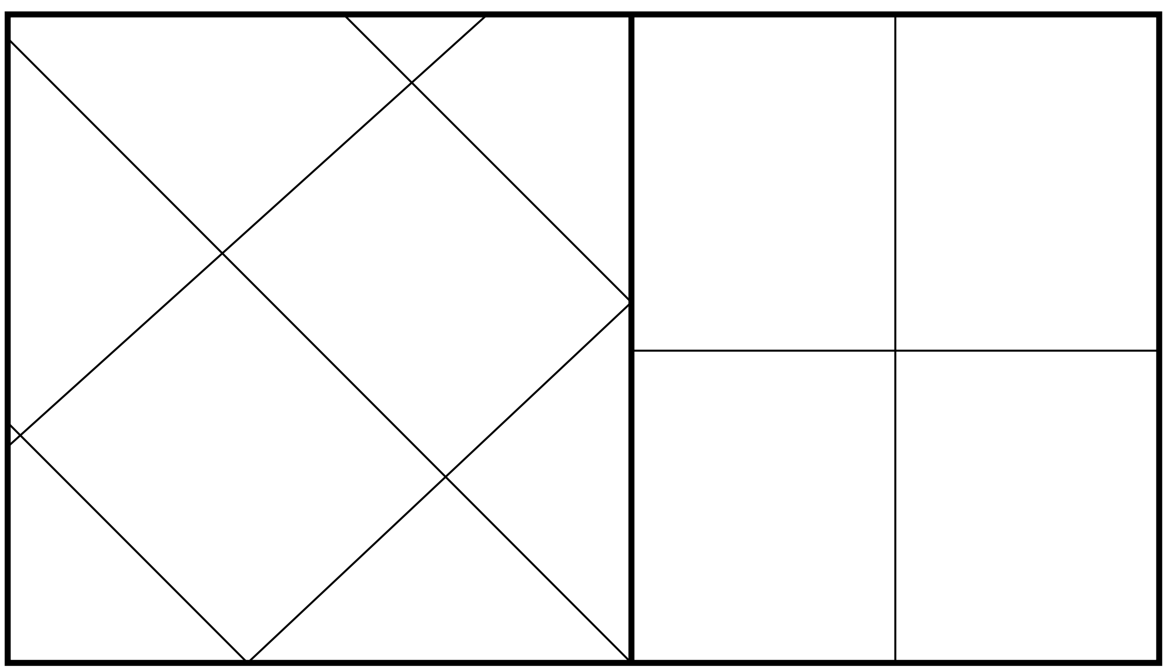
The activities that were under consideration included the laying of face brick, the tiling of the floor and walls of the toilets and kitchens, and painting. Two, four and one Task Groups of face bricklayers, tilers and painters respectively were under observation. The first facebrick crew (Task Group M) had an average of four workers; two artisans and two bricklayer-helpers (See Table 5.4). The second team had an average of ten workers; four bricklayers and six bricklayer helpers. The first three tiling Task Groups as shown in Table 5.6, belonged to one subcontractor and they had an average of two workers; one tiler and one tiler-helper. The fourth tiling group was composed on average of 2 tilers and one tiler-helper. The painting crew was composed of 2 painters.

Work layout and methodology

The work layout of the face bricklaying activity was very similar to that of Project A. The preparation of the mortar was centrally located and the two crews were about ten metres apart. A distance of fifteen metres separated the closest crew from the mortar crew. The bricklaying-helpers had an additional duty of transporting the mortar and bricks in wheelbarrows, which was not identical to Project A. The face brick, just like the mortar were centrally located and were about seven metres away from the mortar crew but eight metres away from the closest bricklaying crew. It must be mentioned that there were more than two bricklaying crews working on this construction site. Task Group M was charged with erecting a plumb face-brick wall directly against an already constructed stock brick wall such that the former wall served as the exterior wall. The interior wall had already been plastered at the time of observation. Task Group O was responsible for constructing concurrently, an interior and exterior wall directly in contact with one another. The latter wall was constructed with face brick whilst the former wall was constructed with stock brick. It may be seen from this description that the work content/design complexity for the two different face-brick crews was not the same. The method of hoisting mortar was very much the same as in Project A. The only difference, when it came to the hoisting of the bricks was that the bricks were hoisted one at a time instead of in two’s as witnessed in Project A. The actual bricklaying mechanism by the bricklayers in Project B, although the same as in Project A, required extra attention for the mortar joints; the finishing of the mortar joints between courses of masonry units of the brickwork was done by the helpers using the simple hand tool called a jointer. This activity by the helper is what gives face brickwork its neatness and also prevents water or rain from seeping into the brick wall through the mortar joints. There was also an entirely different team responsible for the erection of scaffolding and this was also the situation as observed on Project A. The scaffold team was in addition required to adjust the shutters/platforms on the scaffold as per the instruction of the bricklayers. This particular task, as in the case of Project A, was the sole responsibility of the bricklayers.

The four tiling crews mentioned above worked on the entire site. The first three crews, although they were working in different locations, shared one tile-cutting machine. The fourth crew had a tile-cutting machine at their disposal. About thirty percent of the tiling was composed of floor tiling. The major patterns of tiling constructed were the diamond and standard patterns as shown in Figure 5.2.

Figure 5.2: Tiling patterns constructed



Diamond Pattern Standard Pattern

The work layout of the painting crew was haphazard. This was because the area of the wall surfaces to be painted was not continuous but rather in patches and this was due to the fact that the on-going plastering was also being done haphazardly. As a result, the painting crew was continuously moving from one wall surface to another within very short intervals. The painting crew relied on the scaffolding crew in the erection of scaffolds.

5.4 Method of Approach

An activity-logging sheet was designed specifically for the observation of the building activities. This type of logging-sheet is commonly referred to by the ILO as the study form. This form captures the details of a Task Group, the main activity being performed, the duration of the sub-activities involved, the delays encountered, and the quantity or volume of work done by the crew size in a given day. It also outlines the composition of the Task Group and the kind of building being executed. Figure 5.3 below is a sample of the study form used for Projects A and B.

Figure 5.3: A sample of the daily Activity log sheet.

Daily Activity Records

Project Type: Date of Study:

Subcontractor: Task Group:

Task execution: Crew Size:

Start Work: End Work:

Crew Output: Relaxation allowance:

Working time/hrs	**Idle time/hrs**	**Remarks**

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	
2	Effort and dexterity	
3	Posture	
4	Fatigue	
5	Visual	
6	Noise	
7	Concentration	
8	Working Conditions	
9	Total (%)	

The column highlighted as ‘remarks’ in this figure was used to capture events that were actually happening during the time in question. All the records on the log sheets can be found in appendix A to E. The nature of the task together with the conditions of the external project environment, determines the relaxation allowance required of the task in question. These factors that determine and measure the relaxation allowance are shown in Figure 5.4.

Fig 5.4: Typical relation allowances (Harris & McCaffer, 1995)

1. Fixed allowance (personal allowance and fatigue allowance) Men = 8%, Women = 12%
2. Effort and dexterity

Light Work   Medium   Heavy lifting   Very heavy   Excessive (e.g. up to 50kg regular arm lifts)

0%   6.0   12.0   18.0   24.0   30.0

3. Posture

Twisting   Bending   Continuous bending   Overhead   Severe restriction of movement

0%   2   6   10   12

4. Fatigue

Temp: low (max 25°C)   Medium (26-35 °C)   High (above 35°C)

Humid: 75%   85%   75%   85%   85%   95%

0%   2   4   6   8   10   12   14

5. Visual   Regular Movement   Detailed Fine work   Exact work

Lightening: Good   Poor   Good   Poor   Good   Fair   Poor

0%   1   2   3   4   5   6

6. Noise

Humming   Normal (i.e. machine)   Considerable (e.g. pile driver)

0%   1   2   3   4   5   6

7. Concentration

Normal   Above normal   Excessive

0%   1

2   3   4   5   6   7   8   9   10   11   12

8. Working Conditions

Normal   Dust or fumes   Protective clothes needed   Extremely unpleasant

0%   1   2   3   4   5   6   7   8   9   10   11   12

Source: Miyanadeniya. (2002)

The relaxation allowance measurement is more accurate when the observer is observing only one task-worker at a time. This was not the case for the above exercise since the author was observing a group of workers concurrently. It was thus difficult to measure the individual idle time for each worker in a crew. In this regard, idleness as depicted in Figure 5.3 refers to the scenario whereby all the workers were not working at a point in time either due to delays due to management or laziness on the part of the crew. Thus the idle time of individual workers due to fatigue is indicated by the relaxation allowance. Because of the difficulty in measuring the relaxation allowance for a Task Group, it has been presupposed that since each individual worker in a group relaxed at a point in time whilst working on any given day, the required relaxation allowance as measured using Figure 5.4 and indicated in Figure 5.3 has no bearing on the idle time also indicated in Figure 5.3. Working time as indicated in Figure 5.3 measures either the productive time used in working according to specification or the unproductive time used in re-doing work that was not done to specification. The unproductive time as a component of the 'working time' column usually has a remark attached to it indicating the cause of the re-work. The unproductive and idle time together, measure avoidable delay.

5.5 Description of field results

Table 5.1 above indicates the building activities observed, the number of Task Groups involved and the total number of observations carried out. Tables 5.2 to 5.7 below provide a summary of the data captured from the detailed daily activity log sheets as documented in the appendices of this report. The salient features in the tables below highlight the composition of a Task Group, the duration of the task, the actual daily output achieved by the Task Group and what the potential daily outputs could have been. The actual output refers to the measured amount of work done by the Task Group within the day whilst the possible output is an extrapolation on the actual output based on eight hours of work. The Basic Conditions of Employment Act 75 of 1997 (BCEA) stipulates that where an employee works for more than five days in a week, he/she is not expected to work for more than eight hours per day.[59] The calculation of the possible output, which was pegged at eight hours per day, was done to ensure conformity to the South African BCEA 75 of 1997. The optimum output measures the potential daily productivity based on an eight-hour working period on the assumption that the sum of the unproductive and idle time is zero. The author has adhered to the formulas used by the ILO in calculating the possible and optimum outputs.[60] The sections below will be used to present the results for the activities observed.

Mathematically put,

$$\text{Possible Output} = \frac{\text{Actual output} * 480\text{minutes}}{\text{Total time (minutes)}}$$

$$\text{Optimum Output} = \frac{\text{Possible Output} * 100\%}{\%\text{ of productive time}}$$

5.5.1 Stock brick

From Table 5.2, it can be seen that Task Groups D & E had the same artisan to helper ratio of 1:1.3 but the actual productivity of Task Group E was about 38% higher than that of Task Group D. Task Group F with an artisan to helper ratio of 1:1.5 had an actual productivity very similar to that of Task Group E. On the average, the Task Groups together with an artisan to helper ratio of 1:1.4 were actually erecting 672 stock bricks within the day. There was the potential of this output increasing by 5% if avoidable

[59] Havenga et al, 2004:225.
[60] Miyanadeniya, 2000:82-87 also used these formulas in measuring productivity.

delays were reduced to zero. On the average, these Task Groups were spending a total of one hour for their tea and lunch breaks.

One significant observation made by the author was the continuous addition of water by the bricklayers to the already prepared mortar whilst laying the bricks. In many instances the mortar bed was in a slurry form. It is the view of the author that the lack of plasticizer or lime in the mortar, did not make the mortar sufficiently fatty and also, the mortar could not retain the mixing water, hence the continuous addition of water. The initial impression of the water which was in bottles and placed on the platform was that they were meant for drinking. The lack of lime or plasticizer in the mortar is more of a management issue than a technical one that should be attributed to the bricklayers.

INSERT TABLE 5.2: STOCK BRICK

5.5.2 Painting

The summary of the field results is shown in Table 5.3 below. This was the only task that did not employ helpers. It can be seen that Task Group C on average, started and ended work later than their counterparts. The average daily actual productivity of a painter in Task Group C, was higher than a colleague in Task Group L. Whereas the former had the potential of increasing this productivity by 155% if avoidable delays were reduced to zero, the increment potential of the later is 111%. The average daily actual productivity of a painter belonging to Task Groups C and L as a unit was 37.4 square metres with a potential to have this increased to 90 square metres if avoidable delays were zero. Although both crews spent less than eight hours working a day, Task Group L spent on average, an extra 23 minutes beyond the assigned one hour for both tea and lunch break (see Table 5.7).

INSERT TABLE 5.3: PAINTING

5.5.3 Face brick

In Table 5.4 below, the work content for Task Group M was different from that of Task Group O; Task Group M were in charge of erecting an exterior wall with face brick against an already erected interior wall constructed with stock brick whereas Task Group M were erecting both the interior and exterior walls concurrently. The average daily actual productivity of Task Group M comprising one artisan to one helper was approximately 180 face bricks. That of Task Group O with an artisan to helper ratio of 1:1.4 was 502 bricks comprising 226 face bricks and 276 stock bricks. If avoidable delays were reduced to zero, Task Group M and O could have increased their outputs by 30% and 68% respectively. The time spent by both crews working was on average less than eight hours per day. Task Groups M and O on the average were spending an excess of 13 and 20 minutes respectively on their tea and lunch breaks.

The addition of water by the bricklayers to the already mixed mortar as observed on the stock brick sites also occurred on the face brick site.

INSERT TABLE 5.4: Face brick

5.5.4 Plastering

The two plastering teams spent approximately seven and half-hours per day on average working. With an artisan to helper ratio of 1:1.4, their output on any given day averaged 19 square metres per day, although Task Group B on average had a higher output than Task Group A. The avoidable delay experienced was almost zero and hence it is obvious from Table 5.5 that the averaged actual output (19 square metres) for both groups was very close to that of the optimum output (21 square metres). Whilst Task Group A on average was spending 2 minutes in excess of the stipulated tea and lunch break, Task Group B was short by 5 minutes (see Table 5.7).

INSERT TABLE 5.5: Plastering

5.5.5 Tiling

All four tiling teams spent on average between 25 to 30 minutes less than the one-hour stipulated time for both tea and lunch break (see Table 5.7). This was because they started work at almost the instant when tea break was approaching. In Table 5.6, it can be seen that on average, they started work at 8:52 a.m whereas tea break started at 9:00 a.m. On average, the four tiling teams spent approximately six hours per day on the site. With an artisan to helper ratio of 1:0.7, the average daily actual output for all the tiling teams was 8 square metres per day with potential to increase to 15 square metres if avoidable delays were reduced to zero.

INSERT TABLE 5.6: Tiling

INSERT TABLE 5.7: Breakdown of tea and lunch breaks.

5.6 Conclusion

With respect to the brickwork, two different methods were used on the construction sites in hoisting bricks onto the platform. With respect to the stock brick, Task Group E achieved the best productivity. In the painting activity, although Task Group C had the best productivity results, the difference in productivity between the two crews was more than a hundred percent. The productivity of Task Group O in the face brick activity was better than Task Group M. The difference in productivity between the two crews involved in the plastering was not substantial. There is no correlation between the productivities of the tiling crews and the composition of the artisan to helper ratio for the tiling activity.

CHAPTER 6: Analysis of results from case studies

6.1 Introduction

The penultimate Chapter of this report takes a critical look at the field results, by analysing Tables 5.2 to 5.7 of Chapter Five. This chapter is broken down into 7 sections. Section Two compares the productivity results with international trends and with South Africa in the 1950s. Section Three compares the current wages paid South African artisans to that of their counterparts in the USA. Section Four assesses the lack of correlation between the low productivity of the brickwork with the high percentages of time spent on brickwork.

The reasons for the low artisan productivity as observed during the field exercise are the subject matter of Section Five. Section Six explains why it is practically impossible within the short term to ensure that present-day artisans attain the productivity rates of the 1950s or that of the other countries mentioned above. Section Seven concludes with a summary of the content of Chapter Six.

6.2 Comparison of productivity result with past trends

Figures 6.1 to 6.5 below show the graphical representation of the output (productivity) data of all the Task Groups. This data has been extracted from Tables 5.2 to 5.6. The actual daily outputs for all the activities observed are far below the productivity norms for 2006 in the United States; a comparison of these tables with Table 4.1 above attests to this. Table 6.1 below is a summary of Tables 5.2 to 5.6, and Table 4.1, relative to productivity norms from the Vereeniging work study.

Table 6.1: A snap shot comparison of productivity norms.[61]

Trade	**Case Study**		**U.S.A (2006)**		**Vereeniging (1950s)**	
	A:H	**Output/day**	**A:H**	**Output/day**	**A:H**	**Output/day**
Stock brick	1 : 1.4	672			1 : 0	1 260
Plastering	1 : 1.4	19m^2/day	1: 0.7	60m^2/day	1 : 0	33,4m^2/day
Tiling	1 : 0.7	8m^2/day	1 : 0	38m^2/day		
Painting	1 : 0	37.4m^2/day	1 : 0	106,84 - 125,42m^2/day		
Face brick	1 : 1.4	179	1: 0.7	483-600	1 : 0	600-700

Note:

A:H represents the mean artisan to helper ratio

The productivity rates realised from the Vereeniging work-study in the early 1950's and which subsequently became the established norms were much higher than the productivity rates from the two case studies in Table 6.1.. Artisans with accredited certification performed the building activities undertaken in Vereeniging and the United States whereas the artisans from the two case studies considered had no accreditation; only one of the painters had accreditation. Of all the activities observed it was only the stock brick Task Group that worked on average for more than eight hours a day on site.

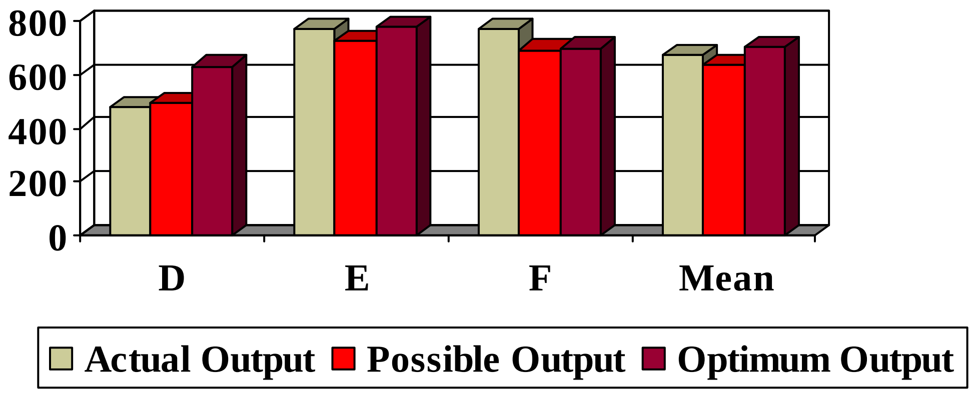
6.2.1 Stock brick

The 'mean' as represented in Figure 6.1 represents the average of the actual, possible and optimum outputs for Task Group D, E and F. The mean value is represented by an artisan to helper ratio of 1:1.4. It was mentioned in Chapter Three that a Bantu artisan laying solely stock brick in the 1950's was required to lay approximately 1 200 bricks per day. The actual, possible and optimum output figures for the mean- Task Group are lower than the 1950's figures and this represents close to a 50% decline in actual productivity when the actual output of the mean-Task Group is compared with the figure from the

[61] See Table 6.3 for a detailed snap shot comparison of brickwork productivity norms.

Vereeniging work study. Although a substantial average of 98% of the daily total time spent on the construction site was used for work activities, this did not translate into increasing the mean actual output substantially (see Table 5.2).

Fig 6.1: Task Groups productivity in the laying of stock brick.



Note:

Actual Output is the average of all the observed daily actual outputs of a given Task Group;

Possible Output is the Actual Output based on an eight-hour work a day by the Task Group;

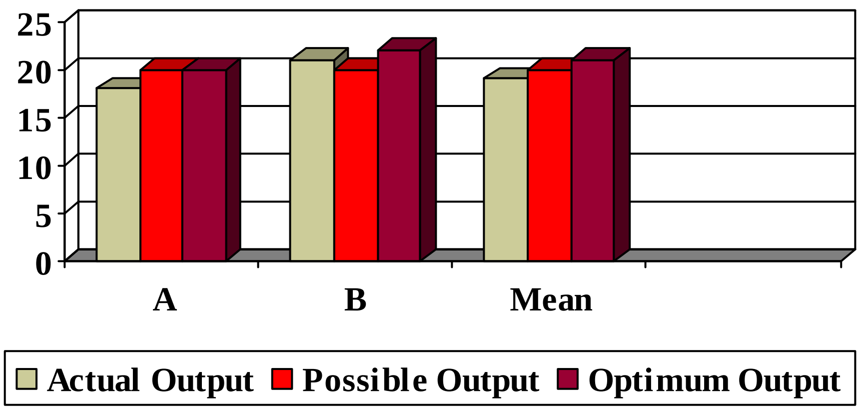
Optimum Output is the Possible Output when unproductive and idle time of the Task Group is reduced to zero. See page 94 for exact formulae used in determining Possible and Optimum Outputs.

6.2.2 Plastering

In Figure 6.2, the mean value also represents an artisan to helper ratio of 1:1.4. The baseline figures deduced from the Vereeniging study required an artisan to plaster a minimum of 32 square metres per day. This productivity figure has declined by approximately 40% when it is compared with the actual output of the mean value in

Figure 6.2. The productivity norm for the year 2006 in the United States requires an artisan to helper ratio of 1:0.6 using a mixing machine of capacity 96 cubic feet to plaster on average 65 square metres per day. With reference to the two case studies considered, an average of 96% of the daily total time was used for work activities (see Table 5.5). From Table 3.6, it was mentioned by the source that the expected actual output in South Africa for an artisan to helper ratio of 1:1 must be between 8-12 square metres per day; this is lower than what was obtained in the two case studies.

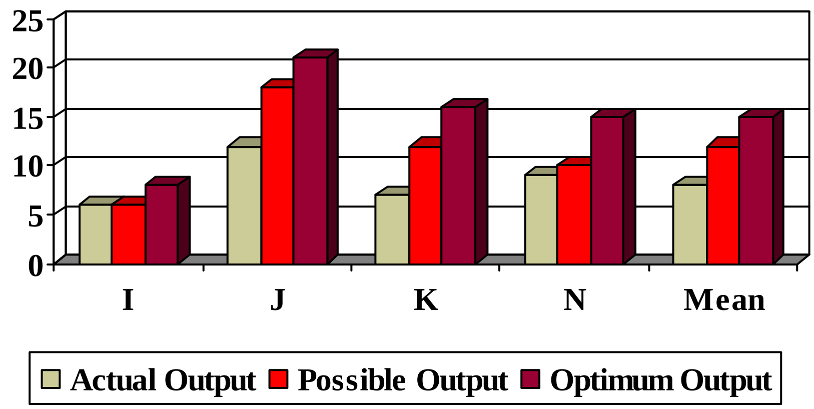
Fig 6.2: Task Groups productivity in Plastering.



6.2.3 Tiling

In Figure 6.3, the mean productivity values are based on an artisan to helper ratio of 1:07. The mean-actual output for this ratio was 8 square metres per day. The 2006 artisan productivity norm in USA for tiling shows that a floor tiler is required to lay an average of 38 square metres per day. It can be deduced from the two case studies above that the mean actual productivity is approximately only 20% of the full capacity of a tiler in the United States. Table 3.6 above requires a South African artisan with one helper to lay an average of 30 square metres per day. The mean –tiling team spent an average of 4,5 hours per day on the site either working or idling. 81% of the 4,5 hours was spent doing productive work.

Fig 6.3: Task Groups productivity in tiling.

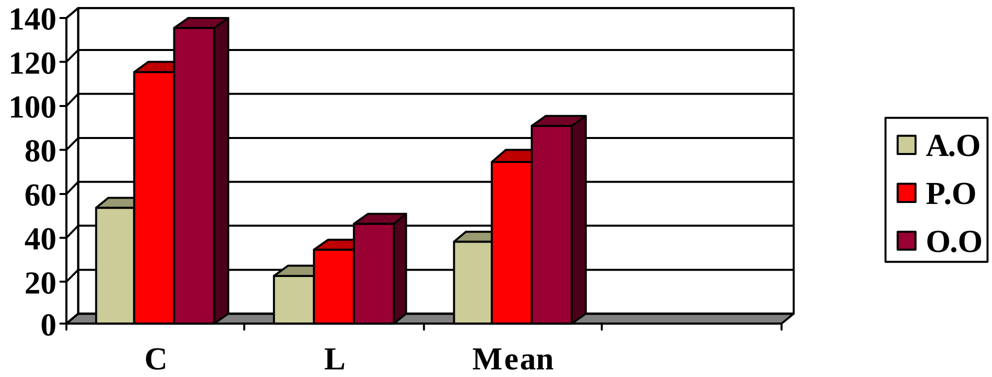


6.2.4 Painting

The mean values in Figure 6.4 represent the productivity of one painter. The mean-actual productivity was 37.4 square metres per day. The only artisan with the accredited certificate was in Task Group L. His presence in the team did not actually impact on their average productivities. This was because the plastering work was slow and they hardly had the space to work on.

The average daily total time as depicted in Table 5.3 is only 52% of the eight hours required a day. Of this, 83% was spent productively. The 2006 artisan productivity norm in the USA for 1st coating shows that a painter is required to paint an average of 125 square metres per day using a roller as a painting tool. The mean-actual productivity is only 30% of that of the USA. The expected rate for a South African painter as shown in Table 3.6 is from 45 to 50 square metres per day.

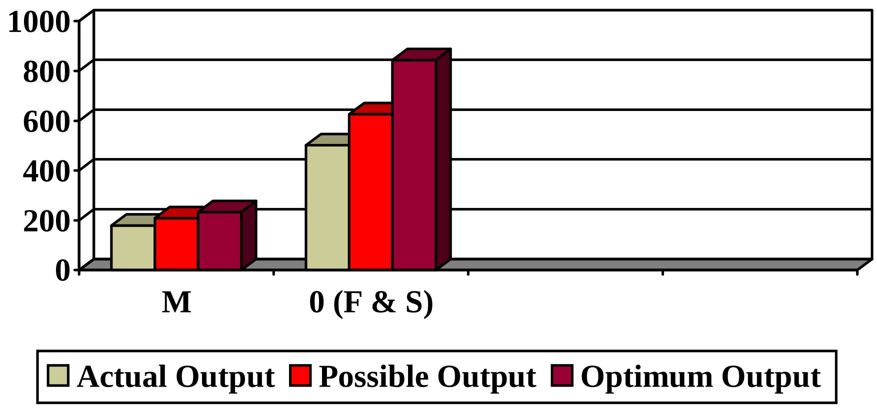
Figure 6.4: Task Groups productivity in painting.



6.2.5 Face brick

With an artisan to helper ratio of 1:1.4, the mean-actual output was 179 bricks per day. The main reason for the low output of Task Group M was that the existing stock brick wall had some defects, mainly due to lack of plumbness, and as a result it was required of the bricklayers to chisel sections of the facebrick or break it into two before laying them. Once the face brick were laid, it was not possible for someone to determine that they were not full bricks. It was practically impossible for the author to find out how much time it took for each face brick to be chiseled or broken into two before it was laid. Thus the time taken for this has been considered as productive time and a part of the actual bricklaying period. Again the facebrick artisan productivities are lower than the productivity Figures from the USA (500 bricks per day), Table 3.6 (400-500 bricks per day) and the Vereeniging study. 85% and 84% of the average daily total time used by Task Group M and O respectively constituted productive time.

Fig 6.5: Task Groups productivity in the laying of face brick.



6.3 Trend of wages of artisans

Table 6.2 compares the basic hourly wages of some categories of artisan as obtained from the case studies with that of the United States.

Table 6.2: A comparison of USA hourly rates with case study.

Trade	Basic hourly rate ($)	Hourly rates(R)
Bricklayer	36.55	13.40
Bricklayer Helper	27.75	5.00
Painters, Ordinary	31.70	16
Plasterer	32.45	16
Plasterer helper	27.90	6
Roofer, tile & slate	30.60	30 per sq metre
Roofer, Helper	22.55	
Tile layer	34.25	
Tile layer, helper	26.50	

The incompleteness of Table 6.2 was due to the unwillingness of some of the Task Groups to divulge information. The author is of the view that although the wages may not scientifically represent norms for South Africa, they do not vary that much from wages on other building construction sites (in Gauteng at least). The labour component of the tiling work was subcontracted by the main contractor at a rate of 30 rands per square metre. According to the foreman on Project B, bricklayers were paid an amount of 20 Rands an hour, eight years ago (i.e. in the late 1990's), which is equivalent to about 35 Rands in current terms. Thus, the low wages paid to today's bricklayer (and for that matter artisans in general) is one specific reason for correspondingly low artisan productivities. Due to the lack of financial motiviation, there is no sense of pride and urgency on the part of the current day artisan. All the workers on both sites were time-rated employees. The unwillingness of the employers to employ them as task-based employees stems from the fact that they might not be able to pay them for no work done when avoidable delays are due to management; the labour laws in South Africa requires tasked-based workers to be paid when this condition prevails. The time-rated employee to some extent is not under any pressure to perform by working faster since he or she will be paid the approved rate irrespective of the volume of work done in a day.

6.4 Analysis of the components of brickwork productive time

Under section 6.2, it was mentioned that an average of over 84% of the daily total time spent on brickwork constituted productive time. On the stock brick sites, the average daily total time exceeded the stipulated eight hours. The average daily total time spent on the face brickwork was approximately 90% of the stipulated eight hours required daily on any construction site. Considering the fact that the productive time and the average daily total time were very substantial, it is intriguing to note that this did not impact positively on the mean-actual daily outputs. In other words, if the unproductive and idle times were reduced to zero, as measured by the optimum productivity, the productivities would still not come closer to the productivity norms during the 1950s and that of some of the

European countries outlined in Table 4.3. Table 6.3 below compares the optimum productivities from the case study with that of Table 4.3.

Table 6.3: A snap shot of brickwork productivity norms and rates.

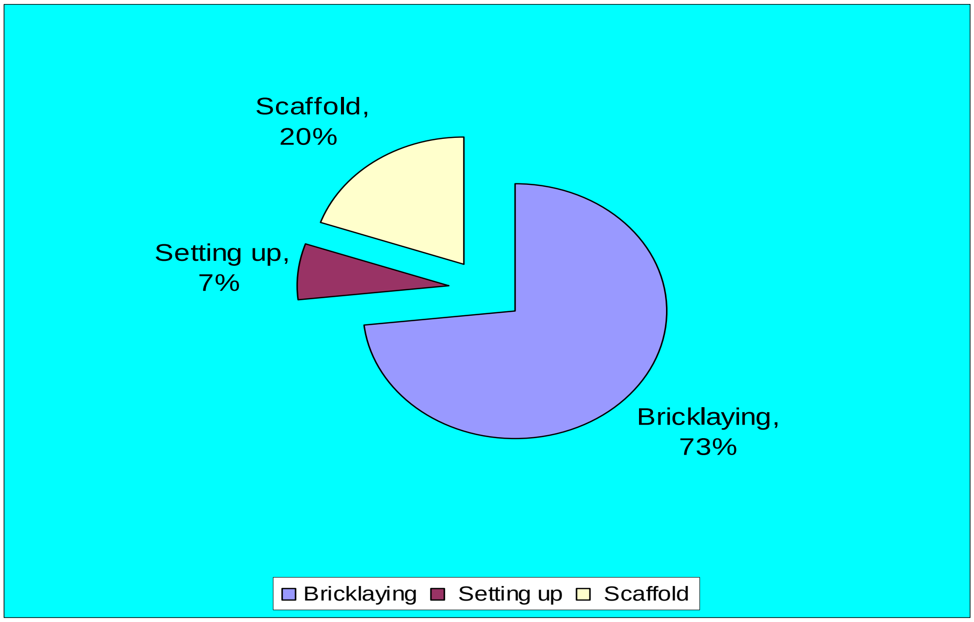
Country	**Artisan to helper ratio**	**Daily Output/ (# of bricks)**	**Daily Output after improved methods**	**Optimum Productivity**
Russia	1 : 0		1,600-1,900	
E. Germany	1 : 0	850	1,500	
U.K	1 : 0	1000	1,250	
RSA-Vereeniging	1 : 0	600-700		
RSA-Vereeniging	1 : 0	1 260 Stock bricks		
RSA- Case study	1:1.4	179		233
RSA- Case study	1:1.4	672 Stock bricks		702 Stock bricks

In an effort to find specific reasons for the low productivity, the author categorised the productive time into three, based on the sub activities involve in carrying out brickwork and observed the mean time taken to execute these sub activities under face and stock brickwork. The three broad sub-activities were:

1. Setting up- This involved the setting up of the fish-line to ensure horizontality of the brick courses and the plumbness of the brick wall.
2. Scaffolding- This involved the movement of shutters (i.e. the platform on which the bricklayers stood) on the scaffold, the hoisting of bricks and mortar onto the shutters.
3. Bricklaying- This was the main activity and involved the spreading of the mortar bed with a trowel, stooping to pick up bricks and the placing of the bricks into position on the mortar bed.

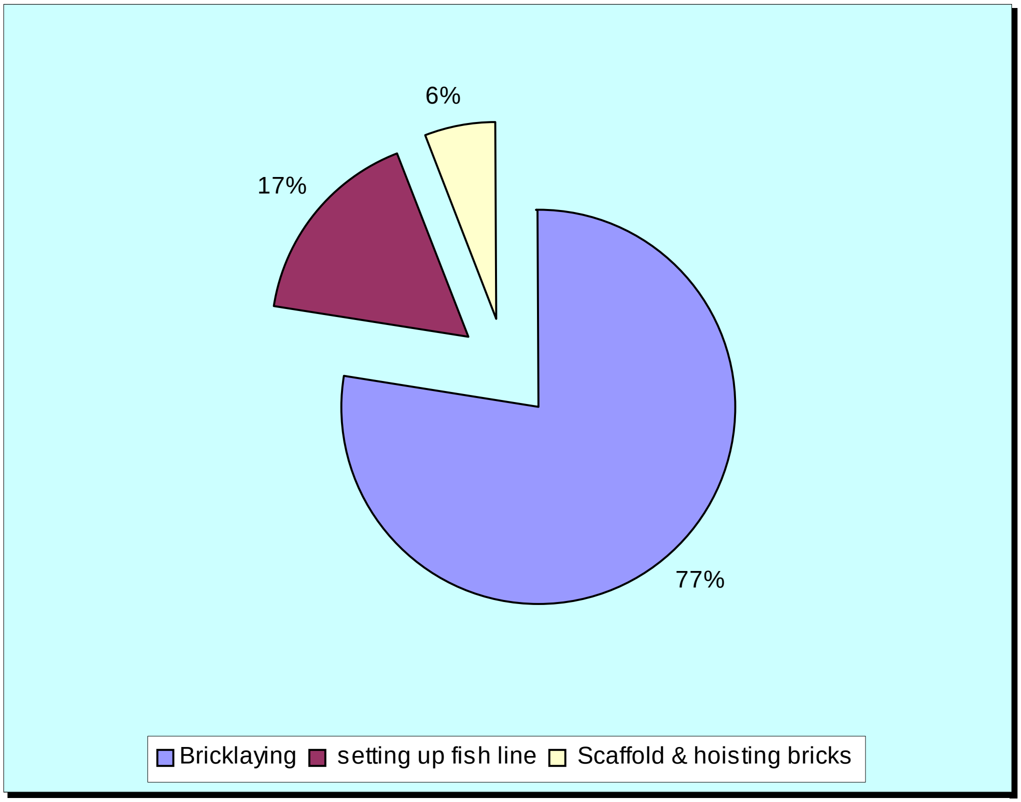
Figures 6.6 and 6.7 show the percentage composition of the productive time with respect to the three broad categories outlined above.

Fig 6.6: Percentage composition of stock brick productive time.



The bricklaying sub activity is the key driving force that determines how many bricks can be laid in a day. The percentage composition of the sub activities in Fig 6.6 is in the right proportion and hence does not support and explain the reason for the low stock brick productivity. The trend in Fig 6.7 is similar to that of Fig 6.6; the only difference is that whereas in Fig 6.6 the percentage composition for the scaffold is greater than the percentage composition of the setting up, the opposite is the case for Fig 6.7. This must be the case since the face brickwork is a finished product and as such it requires precision in the setting up of the fish line to ensure that the brick courses are truly horizontal and the brick wall as a whole is plumb and up to the quality standard. The stock brickwork is usually not a finished product since subsequent activities such as plastering and painting follow suit to cover up the roughness of the stock brick wall.

Fig 6.7: Percentage composition of face brick productive time.



6.5 Some specific reasons for the low productivity

6.5.1 Within management control

1. **Overloading of shutters with bricks**

The greatest delay associated with the brickwork had to do with the de-hoisting of bricks from the shutters on which the bricklayers stood onto the floor level at any time the shutters had to move up. Shutters are moved up any time the bricklayers laid bricks up to their nose level. The bricklayers together with their helpers did not have a measure of how many bricks were required on the shutters until the work reached nose level. Thus, there was routine overloading of the shutters with bricks and the subsequent removal of the remaining bricks onto the ground level to allow the shutters to move up for the bricklaying cycle to continue; this process of de-hoisting of bricks contributed to the delay and hence the lower productivity of the bricklayers. The routine occurrence of this process should have prompted management to correct this by ensuring that the supervisors trained and alerted the crew on how to estimate the number of bricks a shutter can hold at any time a shutter is elevated.

The author observed during brickwork that the shutters were moving up at an interval of 1 metre. With a brick course of 15 metres long, an average of 840 bricks were required to be laid before the shutters could move up by a metre. This means that to avoid the de-hoisting process, a shutter of 15 metres long must hold 840 bricks any time the shutter moves up by one metre. With this preamble in mind, it is possible to deduce how many bricks would be required for any length of shutter on condition that the shutters move upwards at an interval of 1 metre. The dimensions of the bricks must also be taken into consideration.

2. **Method of hoisting bricks**

On Project A, the process of hoisting bricks was twice as fast as on Project B because in the former the bricks were hoisted two at a time, whereas in the latter only one was hoisted at a time. Adequate supervision and training could have quickened the hoisting process on Project B.

3. **Poor remuneration and its effects**

The poor salary remuneration to the workers has generated a lack of pride in these trades and hence there is a lack of urgency on the part of the workforce when working.

4. **Lack of basic tools**

With respect to the tiling activity, three of the Task Groups shared a common tile-cutting machine. This contributed to delays in that the tilers had to move from their working location and at times queue in order to use the tile-cutting machine. If each team had one tile-cutting machine, the delay would have been avoided. According to the team leader they were not in a position to afford an extra machine since each one was being sold at a price of five thousand rands.

5. Work availability

The painting crews in many instances worked slowly because there was no work available to be done. This normally arises when the plastering team works at a slow pace. It is therefore necessary for painting activities to be scheduled in such a way that it lags behind the plastering activities by a substantial time; this time lag, is what most project and construction managers fail to determine accurately. This requires determining the productivity rate of the plastering team and that of the painting in order to estimate the duration by which the painting must lag behind the plastering. On well managed sites, the last few hours of the previous day's plastering are painted in the first few hours of the next day.

6. Lack of adequate supervision

For the plastering, face brick, stock brick and painting activities which were studied, the ratio of the number of Task Groups to a foreman was extremely high; there was only one foreman to a particular activity. It was observed that the sense of urgency with which the workers went about their tasks improved any time the foreman was on that particular work-location. Once the foreman was out of sight, the pace of work slowed down considerably.

6.5.2 Inadequate technical skills

1. Low skills level

The two case studies above had good indicators such as high productive time with an equally high percentage of the sub activities spent on bricklaying. The daily total time spent, based on an eight hour-shift was also high. Generally such good indicators do yield higher productivity but this was not realised for the two case studies. The only reason for the lower productivity rates achieved lie in the low skills level of the workforce and this is accounted for by the majority of the workforce not having any accredited training and certification. The low skill levels have further contributed to a slow pace of work since the workforce need more than ample time to work to the required specification. The speed with which a skilled worker can work comes with experience; thus, any financial incentive to a low level skilled worker towards stepping up the pace of work could result in the proposed work not being done to the standard requirements since undue mistakes will be made whilst rushing to do the work.

Interaction with foremen

During the author's interaction with the site foremen, they stated categorically that it was difficult in the post-apartheid era to find good bricklayers who could construct facebrick walls with little supervision. The site foremen were artisans from the old apprenticeship system. They were also of the view that the quality and strength of houses in the post-apartheid era is not as good as those built during the Apartheid period. As an example, they cited the complaints of numerous cracks in the RDP houses and compared this to some apartheid houses built 50 years ago, which according to them are still standing firm. Asked why this was the case, they said that bricklayers of today do not understand why it is not right for one to lay more than ten courses of bricks on top of a foundation which has just been built and not cured; there is the need to allow the foundation to cure effectively before putting extra weight on it. According to these foremen interviewed, the bricklayers of today also do not understand why the bricks they lay must interlock (i.e stretcher bonds) within the brick-course matrix. In reaction to this statement, the author asked a few of the bricklayers why the bricks had to interlock and their general reply was that it made the brick wall nice. This confirms the statement earlier attributed to Hodge (1993) that a bricklayer must not only demonstrate the ability to lay bricks but must also understand why it is being constructed in a given way. The Foremen also mentioned that the basic wages paid to these categories of artisans mentioned in the case studies are the lowest in the last eight years. The author noticed that quite a substantial number of the artisans and helpers were foreigners from the Southern Africa region.

6.6 Achieving apartheid productivity norms

It is rare in this current era to find artisans of the old apprenticeship system on construction sites with their job qualification as artisans. They have been reduced almost to the point of extinction because most of them either emigrated during the dawn of the new post-apartheid era, retired or are currently pursuing different occupations. With this in mind, together with the low skill levels of the present-day artisan, it is the author's view that it is practically impossible within the short term to immediately get the present-day artisan to attain the productivity norms of the 1950s, 1960s and that of the European countries in the 1950's. This practical impossibility is compounded by the following difficulties facing the current system:

- Contractors in general are unwilling to pay the standard wages to the few artisans with the accredited certification because there is an abundance of so-called artisans without any accreditation.
- Most of these un-accredited artisans are not aware of how they can attain accreditation. There seems not to be any encouragement from Contractors in persuading their artisans to go through the mill to get an accreditation.
- The unwillingness of these artisans to get the required certification also stems from the fact that currently there is an abundance of building work on-going that will earn them some financial remuneration and hence they cannot afford to go back to the classroom in this era of increased job availability.

6.7 Conclusion

The mean artisan productivities and basic wages obtained from the construction sites are below what pertained in the 1950s, USA and some of the European countries. With the exception of the stock brick Task Groups that spent more than eight hours a day on average on the site, all the other Task Groups time spent, ranged from four hours to eight hours a day, on average. The high percentage of the productive time relative to their total time spent on the sites did not result in high productivities; one of the major reasons being that the calibre of artisans used lacked the requisite high level skills demanded by this task. Some of the managerial inefficiencies which contributed to the general low productivity included the poor method of hoisting bricks, overloading of the platform of the scaffolds, lack of an adequate number of tile-cutting tools and lack of adequate supervision of Task Groups. From the field observation and analysis of the field data, the author is of the view that the skills problem outweighs the managerial inefficiencies, and as such, the former impacted more negatively on the low productivities achieved than the latter. This remark above, contradicts the general view of most researched publications such as the ILO (1979) that managerial problems are the major cost of low labour productivities. **Until artisans reach a certain level of skills it would not matter how good management is.**

With the low level of skills associated with the present day artisans, it is the opinion of the author that, in the short term, BIFSA must not only concentrate on the use of a financial scheme as a motivating tool to get the present day artisans to step up their pace of work in an effort to achieve the productivity norms of the 1950s, and that of some of the countries mentioned above; the focus in the short term must include the introduction of formal training for this category of artisans at a highly subsidized rate.[62] This formal training should include:

- Work layout organization (e.g. shuttering/scaffolding and brick handling);
- Method(s) of brick laying (i.e. how to place bricks and mortar).

The formal training must run concurrently with a programme that will aim at enrolling retired and emigrated artisans from the old apprenticeship school, to serve as supervisors in order to improve upon the poor supervision on building sites.

[62] In a series of personal communications with Allyson Lawless in September 2006, she was of the view that the focus should be on the re-introduction of night classes for these artisans, as was done in the apartheid era. According to Allyson Lawless, her late father was a plumber who attended the night classes after the day's work.

CHAPTER 7: Conclusions and Recommendations

7.1 Introduction

The current enormous desire of third world countries in this technological age to use employment-intensive construction is laudable considering the high levels of poverty, lack of skills and unemployment facing the people. The sustainability of employment-intensive construction is very dependent on its economic viability and subsequently, on the labour productivity of the workforce. Low artisan productivities give room for the elite, who do not have an adequate knowledge in the field of construction, to desire and opt for a high technological intensity in construction work. It is in this regard that society and governments as a whole must work hard to maintain a high standard of artisan productivity.

The research study has focused on the trend of artisan productivities of some selected building construction tasks in South Africa and on the international scene. The study demonstrated that artisan productivities of some selected tasks in South Africa have indeed dropped as has been speculated during the past decade by some professionals within the construction sector. It also demonstrated the specific reasons for the low artisan productivities as observed during the fieldwork, which is a component of the research study. The findings of the research indicate the difficulties facing the South African building sector in its efforts to transform itself within the short term to achieve productivity rates which compare to the productivity norms of the time when formal artisan training systems were in place.

The establishment of productivity norms in the building industry dates back to at least the late 18th century.[63] Unfortunately artisan productivities have not kept pace with the

[63] Clarke, 1992:163.

conventionally accepted productivity norms due to several reasons which include wages of artisans.

The subsequent section of this Final chapter will focus on summarizing the key features in this report. It highlights the main objectives of the research, how it was pursued and assesses whether the objectives, which were set at the beginning of the research, have been met. Section 7.2 concludes by highlighting the key findings of the research and hence the implications of the findings of the research study. In section 7.3, general recommendations are made as to the way forward to get the building industry to improve upon artisan productivities. The recommendations will also focus on new areas that need to be researched within the artisan productivity framework as set up in the research.

7.2 Summary and conclusions

The lack of consensus on what is exactly meant by the concept productivity amongst researchers and construction managers has led to different definitions of productivity. Section 2.2 established the uniqueness of the productivity concept and differentiated it entirely from the related terms such as profitability, performance, efficiency and effectiveness. The similarity amongst these terms is based on the fact that they all centred on the output and input variables of a given task. With the exception of productivity, these are all ratios, which have no units. Whereas productivity measures how much work can be done within a given time, profitability focuses on the cost involved in generating revenue through the performance of the said work. Effectiveness requires a task or an operation to be done correctly whereas efficiency requires the task to be done through the right means. Performance is determined by productivity, profitability, quality, dependability and flexibility. Labour productivity for that matter, is a partial productivity, which measures how much work a crew can do in a given time.

The main objective of the research study was to establish baseline artisan productivity trends of some building construction tasks in South Africa and other developed countries from the 1950's to the present in order to be able to assist the Expanded Public Works

Programme (EPWP) to establish norms for building work. The purpose of this was to compare the norms from South Africa with those of the international scene and re-establish baseline norms for South Africa. Once this purpose is achieved, it follows without any conditions that the goal of this research would have been achieve. This is to ensure that the established artisan productivity norms help in the monitoring of employment-intensive construction projects.

In order for the achievement of the main objective and, subsequently, the research purpose to be meaningful, it was also necessary:

1. To review artisan training and relate the factors that affect artisan productivity to the South African context.
2. To collect empirical data on labour productivity through direct field observation.
3. To critically examine the data and use work study techniques to aid in finding out the exact nature of the factors contributing to the achieved levels of artisan productivity rates for the selected tasks in the building sector of South Africa.
4. To outline measures and conditions under which any proposed improved methods would improve artisan productivity rates.

The achievements of these objectives have been outlined in Chapter 3 to Chapter 6 of this report. With regards to the main objective, Section 3.6 described the baseline productivity rates of South African bricklayers and plasterers in the 1950's and 1960's. The work-study carried out in Vereeniging in the early 1950's on the construction of 30 typical 'native' houses was intended to baseline productivity norms. The results obtained indicated that on average:

- A bricklayer could lay between 600 to 700 face bricks per day.
- A bricklayer who doubled as a plasterer could lay 630 stock bricks and plaster 20 square yards (16.7 square metres) all in a day. What this meant was that the bricklayer could either lay 1260 bricks per day when no plastering was done or plaster 40 square yards in a day when no bricklaying was done. A day's work was equivalent to eight hours.

These results were not adjusted to cater for avoidable delays experienced during the execution of the tasks. The National Federation of Building Trade Employees (NFBTE) introduced these results as norms and encouraged every contractor to ensure that these productivities were attained. In the early 1960's to 1970's, the productivity rate for face brick shot up; a prospective bricklayer who was a qualified artisan needed to demonstrate to employees that he was capable of laying a thousand face bricks per day before being employed. The source of the information in Table 3.6 provided average artisan productivity figures currently being attained in the South African building industry currently. By comparing bricklaying and plastering productivities in Table 3.6 to the Vereeniging productivity norms above shows that there has been a decline in artisan productivities, and the Vereeniging norms (i.e. face brick) were low by comparison with the productivity norms that prevailed in the 1960's and 1970's.

With respect to the international scene, some of the artisan productivity norms are highlighted in chapter 4. Baseline artisan productivities have been on the increase in the USA since the 1950's. This achievement has been partly due to an improvement in the working tools used by artisans. In the case of compaction productivity in Heavy Construction, as shown in Figure 4.1, Haas et al reported that the addition of a vibration mechanism onto the existing compactor (i.e. the sheepsfoot roller with 8" lifts) resulted in a 260% increase in compaction productivity. The year 2006 artisan productivity norms in the USA for some selected tasks were shown in Table 4.1. A critical look at Tables 6.1 and 6.3 reveals that the productivities norms in the USA and in Europe have been higher than in South Africa.

In Europe, in the 1950's, different work methods were employed in bricklaying. The two major types of hand tools employed in Europe for bricklaying were the trowel and pan. These different work methods and baseline productivity norms were highlighted in Table 4.3. Table 4.3 also showed that the productivity increment was achieved as a result of work method improvements. The average face-bricklaying productivity norm for the European countries after the work method improvement was over a thousand bricks per day per head; although this was slightly higher than the baseline figures in the 1960's in South Africa, they were comparable.

The UK embarked on a productivity study to the USA in 1949 to learn the reasons for the high productivities in the USA. This trip revealed to the productivity team that artisans in the USA were earning more than their colleagues in the UK. At that time, the UK team contended that the artisans in the USA were earning more because of the high productivity, which resulted in higher production. After the trip, the productivity team concluded that managerial and procurement inefficiencies contributed greatly to the UK's relatively low productivities.

With regards to the collection of empirical data on artisan productivity, the fieldwork of the research focused on two case studies carried out in Johannesburg. The essence of this exercise was to compare current figures with those of Tables 3.6, 4.1 and 4.3. Table 7.1 below is a summary of the average productivities observed from the case study in relation to the USA (2006) and the Vereeniging (1950s) productivity norms.

Table 7.1: Summary of mean-actual productivities.

Activity	Artisan to helper ratio	Mean- Actual Productivity
Case Study		
Laying of Stock brick	1:1.4	672 bricks/day
Laying of Face brick	1:1	179 bricks/day
Painting	1:0	37.4 square metres/day
Plastering	1:1.4	19 square metres/day
Tiling	1:0.7	8 square metres/day
Laying of Face & stock brick concurrently	1:1.4	502 bricks/day
U.S.A (2006)		
Plastering	1: 0.7	60m^2/day
Tiling	1 : 0	38m^2/day
Painting	1 : 0	106,84 - 125,42m^2/day
Face brick	1: 0.7	483-600
Vereeniging (1950's)		
Stock brick	1 : 0	1 260
Plastering	1 : 0	33,4m^2/day
Face brick	1 : 0	600-700

An analysis of Table 7.1 reveals the following:

- The stock brick productivity of an artisan from the case study is approximately 50% of that achieved on the Vereeniging work study.
- The productivity of a plasterer from the case study is approximately 60% of that achieved on the Vereeniging work study.
- The productivity of a tiler from the case study is approximately only 20% of the full capacity of a tiler in the U.S.A.
- The painting productivity from the case study is only 30% of that of the U.S.A.

The mean actual productivity figures from the case study are generally lower than their corresponding figures in Tables 3.6, 4.1, 4.3 and the results from the Vereeniging study. This is a clear indication that:

- Artisan productivities of the above tasks are currently higher in the USA than in South Africa.
- 1950s and 1960s productivity figures in South Africa were generally higher than the current figures from the case study.
- Productivity figures in Post-apartheid South Africa are generally lower than what used to pertain in Europe during the 1950's.
- Table 3.6 may be an over-statement of the current artisan productivity rates across the whole industry in South Africa; it probable represents the top end of the productivity achievements of a small section of artisans within the formal sector[64].

Important observations were made during the fieldwork. Some of these observations are as follows:

- All the artisans and helpers were employed as time-rated employees. The unwillingness of the employers to employ them as task-based employees stems from the fact that they might not be able to pay them for no work done when avoidable delays are due to management.
- The bricklaying crews did not have any clue as to how to estimate the number of bricks a shutter could hold in order to prevent the de-hoisting of bricks when the shutter had to be elevated.
- Three of the tiling crews shared a common tile-cutting machine. This contributed to delays in that the tilers had to move from their working location and at times queue in order to use the tile-cutting machine.
- The painting crews in many instances worked slowly because there was no work available to be done. This normally arises when the plastering team works at a slow pace.

[64] According to the 2002 annual report of BIFSA, formal employment within the building industry was approximately 20% of informal employment.

This research has also demonstrated that the scrapping of the old-apprenticeship system of training contributed to the decline in artisan productivity. In addition, the inability of the old apprenticeship system to qualitatively incorporate the then historically disadvantaged individuals has contributed tremendously to the high number of current artisans without any certified accreditation. In the old apprenticeship system during the 1950’s and mid 1960’s, an apprentice attached to an employer was required to spend one day a week attending theoretical lessons. A prospective artisan during this era needed five years of apprenticeship with a pass in his exams, which were written in the penultimate year before qualifying to become an artisan. Subsequently the years of training were reduced to four and finally apprentices were asked to attend a block release of 3-months a year for their technical and theoretical lessons before the old apprenticeship system was scrapped.

Section 2.8 of Chapter 2, described all the possible factors that can affect artisan productivity. There is no standard classification for the categorization of these factors that affect productivity. Whereas some classification categorized these factors under people related, site related and project related, other types of classification refer to these factors under management control and project/environment related (see Table 2.3).

The fieldwork revealed very specific factors that did contribute to the poor artisan productivities obtained. In the bricklaying task for instance, it was shown that the platform on which the bricklayers stood was always overloaded with bricks. This meant that anytime these platforms had to be adjusted in order for the bricklayers to continue laying bricks, the excess bricks on the platform had to be brought down before these platforms could be adjusted. The task team did not have any idea as to how many bricks needed to be hoisted in adequate quantities onto the platform. After several observations, it became clear to the author that for a 15m length of platform, 840 bricks were required to construct a brick wall of length 15m, 12 brick courses high before the platform was adjusted. In Section 6.4, the percentage composition of the bricklaying sub activities within the productive time revealed that the low productivity of the bricklaying task was largely due to the low skills level of the artisans, which to some extent is further due to the lack of accredited training for these category of artisans. The method employed in the hoisting of bricks onto the platform by the crew on Project B contributed to the low productivity; the bricks were being hoisted one at a time whereas on Project A, they were hoisted two at a time.

With the tiling task, the main factor aside from the low skill levels of the tilers, was as a result of the lack of adequate tools; three of the tiling team were sharing one tile-cutting machine and thus had to spend time (which should have been used productively) in transporting tiles and queuing to cut tiles to shape and size. The painting crew did not always have adequate volume of work to do. Where there was ample work to be done, it was not continuous but rather in patches which required that the painters had to search around looking for available working space and this slowed down their work rate. The attitude of employers towards these artisans has also impacted negatively on their work ethics and pace; the unwillingness to pay the work force the standard basic wages and also to encourage them to go back to school to get accreditation through proper training, has rendered these artisans unpatriotic towards their own profession. Table 7.2 is a list of some of the key factors that contributed to the low productivities as observed from the case study.

Table 7.2: Major factors affecting Case Study productivities.

Artisan Factors	Management Factors
Inadequate technical skills of bricklayers	Overloading of shutters with bricks
Bricklayers lacked the basic skills required in the setting up of fish line	Poor method of hoisting bricks on Project B
Lack of formal training for all categories of artisans	Poor remuneration for artisans and its effects on productivity
Lack of working experience and hence slow pace of work	Inadequate tile-cutting machine for tiling crews.
	Poor scheduling of Painting activity within the matrix of all the major activities
	Lack of adequate supervision of crews

It can be concluded that the low skills level, which is attributed to the lack of proper and accredited training, contributed immensely to the low artisan productivities of all the tasks observed from the field study. Based on the current skills level, the optimum artisan productivities as indicated in Tables 5.2 to 5.6 of Section 5.5 of Chapter 5, reflect the current maximum potential productivities. Although managerial inefficiencies existed, the skills inadequacies contributed more significantly to the low artisan productivities. A critical assessment of the factors contributing to the low productivities from the case study as shown in the conclusions of Chapter 6 revealed that the skills problem outweighs the managerial inefficiencies, and as such, the former impacted more negatively on the low productivities achieved than the latter. This observation above, thus contradicts the general view of most researched publications such as the ILO (1979) that managerial problems are the major cost of low labour productivities. No matter how good management is a high artisan skills level is required to drive productivity rates up.

Until the skills level are generally improved concurrently with the motivation of the workforce (through a financial incentive scheme which will pay standard wage rates), it would be impossible to see significant improvement in artisan productivity. Thus, in the immediate short term, it will be impossible to achieve the artisan productivity norms of the 1950s, 1960's, the USA and that of some of the European countries mentioned in this report.

7.3 Recommendations

The solution to the low skills level of the building industry artisans in South Africa requires a medium to long-term plan. It has taken over a decade for artisan productivity levels to fall to their current levels and as such it will require ample time for rectification. As a medium to long-term measure, the Expanded Public Work Programme must incorporate an artisan learnership programme into the existing contractor programme scheme. The essence of this is to attract the majority of unaccredited building artisans who are unwilling to get the required training because they cannot afford the financial implications. The introduction of such a learnership scheme must provide a monthly wage to these artisans just as is being done under the contractor learnership programme. Improvement in artisan productivity is not specifically an objective of the EPWP contractor learnership; hence the introduction of an artisan learnership scheme will be an added advantage to the EPWP since ultimately contractors under the learnership programme rely on these artisans in the execution of their contracts. It will therefore be necessary for the scope of the contractor learnership programme to widen to include building activities.

BIFSA must start considering the possibility of lobbying the necessary government institutions to introduce legislation that will ensure that the labour force within the building industry is employed on a task based system. Although the author acknowledges the difficulty in setting up task rates for building activities in contrast to civil engineering activities, its implementation will standardized productivities that learner contractors within the EPWP will be expected to maintain. The onus thus falls on BIFSA to first of all, find a mechanism that will break down into the simplest form and categories, all the tasks that can be envisaged under all forms of building works.

As a short to medium term measure to improve artisan productivity:

- There is the need to increase the supervisor to artisan ratio on construction sites. This will to a large extent prevent artisans working at a snails pace whenever a supervisor or foreman leaves the working site.
- Contractors must pay standard and approved wages to artisans with the necessary accreditation.
- With respect to brickwork, it is important that the workforce is taught to correctly estimate how many bricks must be hoisted onto the platform of a scaffold for any particular wall construction. This will reduce the high level of overloading platforms with bricks. The achievement of this will reduce the tendency of de-hoisting bricks before platforms can be adjusted to suit the bricklayer.
- The building industry must explore the possibility of attracting back into industry the old-school artisans who have emigrated or change their occupation.
- Contractors must be forced to encourage those artisans whom they know are highly skilled but without accreditation, to attend the fast-track courses that are currently being run by some institutions for the section of the workforce with prior knowledge of their profession.

Further research topics arising from this study

1. An approach to the incorporation of an artisan learnership programme into the on-going EPWP learnership programme.
2. An appraisal of the optimum method and formulae to determining the measurement of the potential productivity of an employment-intensive building construction Task Group.

Appendices

APPENDIX A:

DAILY ACTIVITY RECORDS ON STOCK BRICK

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 10-07-06

Subcontractor: JDW

Task Group: D

Task execution: **Stock Brickwork**

Crew Size: 7 (4A, 3L)

Start Work: 09:18

End Work: 16:55

Crew Output: **1514 bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
09:18-10:05		
	10:05-11:43	Waiting for scaffolding team to erect scaffolds at new working face
11:43-12:00		Setting up fish line
12:50-14:12		
	14:12-14:35	Shortage of Mortar
14:35-15:07		
15:07-16:40		Movement of shutters upwards and manual hoisting of bricks unto scaffold (6m)
16:40-16:55		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Shopping mall construction
Date of Study: 11-07-06

Subcontractor: JDW
Task Group: D

Task execution: **Stock Brickwork**
Crew Size: 8 (4A, 4L)

Start Work: 07:31
End Work: 16:46

Crew Output: 1746 **bricks**
Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:31-09:00		Cleaning up & mixing of mortar
09:15-10:38		
10:38-12:00		Vertical adjustment of Scaffold and manual hoisting of bricks
	12:30-13:25	Limited quantity of bricks but Ambers want additional stock before they continue
13:25-14:07		Conveyance of bricks (200m from working face)
14:07-14:27		Manual hoisting of bricks up the scaffold
14:25-15:30		
15:30-16:30		Vertical adjustment of Scaffold
16:30-16:46		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

<u>Daily Activity Records</u>

Project Type: Shopping mall construction

Date of Study: 12-07-06

Subcontractor: JDW

Task Group: D

Task execution: **Stock Brickwork**

Crew Size: 8 (4A, 4L)

Start Work: 07:37

End Work: 16:37

Crew Output: **1211 bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:37-08:15		Mixing Mortar and manual hoisting of bricks
08:15-08:46		
08:46-09:00		Lateral adjustment of scaffold unto a new working phase
09:18-11:11		Setting up fish line and hoisting of bricks
11:11-12:00		
12:32-12:50		
12:50-13:41		Manual hoisting bricks
13:41-14:50		
14:50-15:19		Vertical adjustment of scaffold & hoisting of bricks
15:19-16:37		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

<u>**Daily Activity Records**</u>

Project Type: Shopping mall construction

Date of Study: 13-07-06

Subcontractor: JDW

Task Group: D

Task execution: **Stock Brickwork**

Crew Size: 10 (4A, 6L)

Start Work: 07:36

End Work: 16:20

Crew Output: **3153 bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:36-08:10		Hoisting bricks manually
	08:10-09:00	Shortage of bricks
09:16-10:07		Hoisting bricks
10:07-12:00		
12:32-12:40		
	12:40-13:05	Shortage of mortar/bricks
13:05-14:16		
14:16-14:47		Relocation to new face; Starts bricklaying from floor level
14:47-16:20		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 11-07-06

Subcontractor: JDW

Task Group: E

Task execution: **Stock Brickwork**

Crew Size: 5 (2A, 3L)

Start Work: 07:23

End Work: 16:39

Crew Output: 1088 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:23-08:09		Mixing of mortar
08:09-08:45		
08:45-09:00		Lateral movement of scaffold and setting up fish line
09:30-10:07		Hoisting bricks manually unto scaffold
10:07-10:27		
	10:27-11:05	Shortage of mortar
11:05-11:30		
11:30-11:38		Hoisting bricks manually
11:38-12:00		Conveyance of bricks from (100m) to working face
12:40-12:55		Mixing of Mortar
12:55-13:16		
13:16-13:58		Adjustment of scaffold upwards; manual hoisting of bricks
13:58-14:50		
14:50-15:42		Lateral movement of scaffold and setting up fish line
15:42-16:39		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

General Remarks

- Bricks were sometimes conveyed in wheelbarrows 100m from working face because the track (   ) was busy working elsewhere
- Some of the labourers were generally idling whilst bricklayers were busy working. Others were conveying bricks to the working face.
- All the bricklayers waited until the bricks are completely hoisted up before they continue working.

Daily Activity Records

Project ID: Shopping mall construction

Date of Study: 12-07-06

Subcontractor: JDW

Task Group: E

Task execution: **Stock Brickwork**

Crew Size: 6 (2A, 4L)

Start Work: 07:28

End Work: 16:11

Crew Output: 990 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:28-08:20		Conveyance of bricks unto site. Mixing of mortar
08:20-09:00		
09:21-10:04		Adjusting of scaffold upwards; setting up fish line
10:04-10:49		
10:49-11:07		Adjusting of scaffold upwards; setting up fish line
11:07-12:00		
12:36-13:44		
13:44-14:03		Adjusting of scaffold upwards; hoisting of bricks
14:03-15:16		
15:16-15:36		Manual hoisting of bricks
15:36-16:11		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

<u>**Daily Activity Sheet**</u>

Project Type: Shopping mall construction

Date of Study: 13-07-06

Subcontractor: JDW

Task Group: E

Task execution: **Stock Brickwork**

Crew Size: 16 (7A, 9L)

Start Work: 07:17

End Work: 16:39

Crew Output: 5843 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:17-07:46		Mixing and hoisting of mortar
07:46-08:31		
	08:31-09:00	Obstruction by steel framers
09:23-10:48		
10:48-12:00		
12:37-12:46		
12:46-16:39		Start brickwork from floor level

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 14-07-06

Subcontractor: JDW

Task Group: E

Task execution: **Stock Brickwork**

Crew Size: 18 (9A, 9L)

Start Work: 08:26

End Work: 16:48

Crew Output: 7476 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
08:26-08:31		Hoisting bricks
	08:31-08:46	Shortage of mortar
08:46-09:00		
09:17-10:39		
10:39-10:53		
10:53-11:32		Hoisting bricks
11:32-12:00		Crew moved unto a new face 80m away.
12:31-13:07		
13:07-15:49		
	15:49-16:06	Shortage of mortar
16:06-16:48		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

<u>**Daily Activity Records**</u>

Project Type: Shopping mall construction

Date of Study: 11-07-06

Subcontractor: JDW

Task Group: F

Task execution: **Stock Brickwork**

Crew Size: 21 (7A, 14L)

Start Work: 07:11

End Work: 16:41

Crew Output: 6694 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:11-07:31		Cleaning up and mixing of mortar
07:31-09:00		
09:25-12:00		
12:37-16:41		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

<u>Daily Activity Records</u>

Project Type: Shopping mall construction

Date of Study: 12-07-06

Subcontractor: JDW

Task Group: F

Task execution: **Stock Brickwork**

Crew Size: 21 (7A, 14L)

Start Work: 07:13

End Work: 16:47

Crew Output: 6862 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:13-07:36		Mixing mortar. Bricks and mortar are hoisted from ground level to first floor machine intensively
07:36-09:00		
09:18-12:00		
12:38 -16:47		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 13-07-06

Task Group: F

Subcontractor: JDW

Task execution: **Stock Brickwork**

Crew Size: 13 (6A, 7L)

Start Work: 07:42

End Work: 16:44

Crew Output: 3528 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:42-08:01		Hoisting bricks and mixing mortar
08:01-09:01		
09:26-10:13		
10:13-10:59		Hoisting bricks
10:59-12:00		
12:38-13:04		
13:04-14:14		Adjusting scaffold upwards
	14:14-14:49	Shortage of mortar
14:49-15:47		
15:47-16:03		Hoisting mortar
16:03-16:44		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 14-07-06

Subcontractor: JDW

Task Group: F

Task execution: **Stock Brickwork**

Crew Size: 11 (6A, 5L)

Start Work: 08:09

End Work: 16:49

Crew Output: 4622 **bricks**

Relaxation allowance: 25%

Brick dimension: L=220mm, W=100mm, H=70mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
08:09-08:39		Setting up fish line and mixing mortar
08:39-09:00		
09:21-12:00		
12:38-12:54		
12:54-13:52		Adjusting fish line set up
13:52-14:19		Hoisting bricks manually
14:19-16:49		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

APPENDIX B:

DAILY ACTIVITY RECORDS ON PAINTING

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 10-07-06

Subcontractor: Sam Painters

Task Group: C

Task execution: **Painting**

Crew Size: 2 (2A)

Start Work: 09:23

End Work: 14:25

Crew Output: **210 sq metres**

Relaxation allowance: 23%

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
09:23-10:35		
10:35-10:50		Lateral movement of scaffold
10:50-12:00		
12:36-14:45		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	6
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	3
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**23**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 12-07-06

Subcontractor: Sam Painters

Task Group: C

Task execution: **Painting**

Crew Size: 2 Artisans

Start Work: 09:17

End Work: 13:15

Crew Output: **73 sq metres**

Relaxation allowance: 22%

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
09:17-09:49		
	09:49-10:23	Obstruction of work by carpenters
10:25-11:25		Working on a new face
	11:25-11:40	Moved back to old face; still waiting for carpenters to be done on window frames
11:40-11:42		
	11:42-12:00	Obstruction by carpenters
12:41-13:15		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	6
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**22**

<u>Daily Activity Records</u>

Project Type: Shopping mall construction

Date of Study: 13-07-06

Subcontractor: Sam Painters

Task Group: C

Task execution: **Painting**

Crew Size: 2 (2A)

Start Work: 09:39

End Work: 15:28

Crew Output: **94 sq metres**

Relaxation allowance: 22%

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
09:39-09:44		Mixing paint
09:44-10:06		
	10:06-10:19	Standing idle and chatting
10:19-10:48		
	10:48-11:15	Cannot be found on site
11:15-12:00		
12:50-13:11		
	13:11-13:22	Painters chatting but not working
13:22-13:36		
13:36-15:28		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	6
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**22**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 14-07-06

Subcontractor: Sam Painters

Task Group: C

Task execution: **Painting**

Crew Size: 2 (2A)

Start Work: 13:20

End Work: 15:45

Crew Output: 45 **sq metres**

Relaxation allowance: 22%

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
13:20-14:24		
	14:24-14:51	Painters move out from site
14:51-15:45		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	6
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**22**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 19-07-06

Subcontractor: Task Group: L

Task execution: **Painting** Crew Size: 2 (2A)

Start Work: 08:13 End Work: 16:30

Duration of Break: Relaxation allowance: 20%

Break times: 12:00-12:50 Crew Output: 91 **sq metres**

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
08:13-09:00		
09:17-09:27		
09:27-11:26		
	11:26-12:00	Shortage of paint on site
12:30-16:30		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	4
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**20**

NB: No scaffold were used

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 20-07-06

Subcontractor:

Task Group: L

Task execution: **Painting**

Crew Size: 1 (1A)

Start Work: 08:12

End Work: 15:33

Crew Output: 53 **sq metres**

Relaxation allowance: 20%

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
08:12-09:00		
09:36-12:00		
13:36-15:33		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	4
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**20**

NB: Scaffold were used

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 21-07-06

Subcontractor:

Task Group: L

Task execution: **Painting**

Crew Size: 2 (2A)

Start Work: 07:54

End Work: 11:17

Crew Output:12.7 **sq metres**

Relaxation allowance: 20%

Simple tool: Roller

Working time/hrs	**Idle time/hrs**	**Remarks**
07:54-09:00		
	09:36-10:42	Chatting
10:42-11:17		
		No more surfaces to paint due to obstruction by other activities

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	4
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**20**

NB: Scaffold were used

This day was ‘pay day’; hence, it was only half day work

<u>**Daily Activity Records**</u>

Project ID: Office Block & Retail Center construction

Date of Study: 24-07-06

Subcontractor:

Task Group: L

Task execution: **Painting**

Crew Size: 1 (1A)

Start Work: 07:31

End Work: 15:09

Crew Output: 19.3 **sq metres**

Relaxation allowance: 20%

Break times: 12:00-12:50

Simple tool: Roller

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:31-09:00		
09:28-11:58		
12:41-15:09		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	4
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**20**

APPENDIX C:

DAILY ACTIVITY RECORDS ON FACE BRICK

<u>Daily Activity Records</u>

Project Type: Office Block & Retail Center construction

Date of Study: 19-07-06

Main Contractor: G.I.P

Task Group: M

Task execution: **Face Brickwork**

Crew Size: 4 (3A, 1L)

Start Work: 07:32

End Work: 17:08

Crew Output: 65 **bricks**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
	07:32-08:08:09	Erection of scaffold by scaffold team
08:09-09:00		Setting up fish line; conveyance of bricks to work site (from 20m)
09:28-10:25		Setting up fish line; conveyance of bricks to work site (from 20m)
	10:25-12:03	No cement since morning
	12:03-13:06	Cement in but preparation of mortar is delayed by the mortar crew
14:06-15:16		Re -adjustment of fish line
15:16-17:08		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 20-07-06

Main Contractor: G.I.P

Task Group: M

Task execution: **Face Brickwork**

Crew Size: 3 (2A, 1L)

Start Work: 07:31

End Work: 17:05

Crew Output: 350 **bricks**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
	07:31-07:50	Mortar is not ready
07:50-09:00		
09:22-13:00		
14:34-17:05		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 21-07-06

Main Contractor: G.I.P

Task Group: M

Task execution: **Face Brickwork**

Crew Size: 4 (2A, 2L)

Start Work: 07:41

End Work: 13:00

Crew Output: 280 **bricks**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:41-08:08		Mortar is not ready
08:08-09:00		
09:39-13:00		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Nb: This day was ‘pay day’; hence, it was only half day work

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 24-07-06

Main Contractor: G.I.P

Task Group: M

Task execution: **Face Brickwork**

Crew Size: 4 (2A, 2L)

Start Work: 08:03

End Work: 16:36

Crew Output: 630 **bricks**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Productive time/hrs	**Idle time/hrs**	**Remarks**
08:03-08:31		Setting up fish line; preparing mortar
08:31-09:00		
09:23-11:19		
11:19-12:23		Upward movement of shutters and hoisting of bricks
	12:23-13:00	Bricklayer falls from scaffold (6m from ground level). Ambulance called in. Crew observing the scene
13:49-16:36		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Nb: 12 courses of bricks requires the shutters of scaffold to move up 1m

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 27-07-06

Main Contractor: G.I.P

Task Group: M

Task execution: **Face Brickwork**

Crew Size: 4 (2A, 2L)

Start Work: 07:35

End Work: 17:23

Crew Output: 464 **bricks**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:35-09:00		Setting up fish line
09:27-09:54		Chiseling section of stock brick inner wall
09:54-10:14		
10:14-10:39		Upward movement of shutters
10:39-12:07		Chiseling section of stock brick inner wall
12:07-13:00		
13:48-14:29		
14:29-14:44		
14:44-17:23		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Nb: 12 courses of bricks requires the shutters of scaffold to move up 1m

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 27-07-06

Main Contractor: G.I.P

Task Group: **O**

Task execution: **Face & Stock Brickwork**

Crew Size: 11 (4A, 7L)

Start Work: 07:52

End Work: 17:03

Crew Output: 1,337 Face brick**, 1,737 Stock brick**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
07:52-09:00		
	09:28-10:39	Shortage of mortar
10:39-11:12		
	11:12-11:31	Shortage of mortar
11:31-13:00		
13:55-14:09		
14:09-14:13		Making room for Sill measurement
14:13:14:51		Backfilling the sides of the wall of the foundational bricks
14:51-15:38		
	15:38-15:50	Shortage of face brick
15:50-:15:57		Setting up fish line
	15:57-16:06	Hanging around but not working
16:06-17:03		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

Nb: Approximately 75% of these bricks were erected before the lunch break; The general foreman actively took part in the bricklaying up to the lunch break

<u>Daily Activity Records</u>

Project Type: Office Block & Retail Center construction

Date of Study: 28-07-06

Main Contractor: G.I.P

Task Group: **O**

Task execution: **Face & Stock Brickwork**

Crew Size: 11 (4A, 7L)

Start Work: 08:17

End Work: 17:47

Crew Output: 470 Face brick**, 470 Stock brick**

Relaxation allowance: 25%

Brick dimension: L=225mm, W=108mm, H=75mm

Bonding: Stretcher (L*H surface exposure)

Working time/hrs	**Idle time/hrs**	**Remarks**
08:17-08:42		Erecting Scaffold, distribution of bricks to bricklayers
08:42-09:00		
09:26-10:33		
10:33-10:55		Rework ordered by foreman due to poor work done by bricklayers
10:55-11:36		
11:36-12:28		Hoisting bricks
11:28-13:00		
13:50-17:47		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	10
3	Posture	4
4	Fatigue	2
5	Visual	0
6	Noise	1
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**25**

APPENDIX D:

DAILY ACTIVITY RECORDS ON PLASTERING

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 10-07-06

Subcontractor: Ohlorst & Partners

Task Group: A

Task execution: **Plastering**

Crew Size: 17 (6A, 11L)

Start Work: 07:30

End Work: 16:00

Crew Output: **124sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Working time/hrs	**Idle time/hrs**	**Remarks**
07:30-09:00		
09:18-11:21		
	11:21-11:31	Shortage of sand for preparing mortar
11:31-12:00		
12:34-16:00		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 10-07-06

Subcontractor:

Task Group: B

Task execution: **Plastering**

Crew Size: 10 (4A, 6L)

Start Work: 09:15

End Work: 17:43

Crew Output: **130 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Working time/hrs	**Idle time/hrs**	**Remarks**
09:15-13:00		
13:50-17:43		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

<u>**Daily Activity Records**</u>

Project Type: Shopping mall construction

Date of Study: 11-07-06

Subcontractor: Ohlorst & Partners

Task Group: A

Task execution: **Plastering**

Crew Size: 3 (1A, 2L)

Start Work: 07:16

End Work: 11:05

Crew Output: **0 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Working time/hrs	**Idle time/hrs**	**Remarks**
07:16-09:00		Re-working on surfaces of previous day's work
09:17-11:05		Erecting Scaffolds on along the walls of the next working face. This should have been the work of the Scaffolding team

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

<u>Daily Activity Records</u>

Project Type: Shopping mall construction

Date of Study: 11-07-06

Subcontractor:

Task Group: B

Task execution: **Plastering**

Crew Size: 12 (5A, 7L)

Start Work: 08:07

End Work: 17:43

Crew Output: **104 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:07-10:50		Re-working on surface of previous work
10:50-13:02		
13:55-17:43		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

STUDY FORM: Crew

Project Type: Shopping mall construction

Date of Study: 12-07-06

Subcontractor: Ohlorst & Partners

Task Group: A

Task execution: **Plastering**

Crew Size: 8 (4A, 4L)

Start Work: 07:21

End Work: 15:57

Crew Output: **78 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Working time/hrs	**Idle time/hrs**	**Remarks**
07:21-08:14		Erecting shutters of Scaffold
08:14-09:00		
09:23-12:00		
	12:51-13:02	Loitering around but not working
13:02-15:57		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

Daily Activity Records

Project Type: Shopping mall Construction

Date of Study: 12-07-06

Subcontractor:

Task Group: B

Task execution: **Plastering**

Crew Size: 8 (3A, 5L)

Start Work: 07:47

End Work: 16:25

Crew Output: **82 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:47-09:14		Preparing mortar and setting up plastering surface
09:14-11:16		
	11:16-11:45	Shortage of Mortar due to the temporal lack of cement
11:45-12:03		
13:00-16:25		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

<u>**Daily Activity Records**</u>

Project ID: Shopping mall construction

Date of Study: 13-07-06

Subcontractor:

Task Group: A

Task execution: **Plastering**

Crew Size: 2 (1A, 1L)

Start Work: 07:18

End Work: 15:50

Crew Output: **16.4 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:18-07:47		Preparing mortar
07:47-08:36		
08:36-09:00		In search of a straight edge for leveling
09:36-11:23		
11:23-11:33		
11:33-12:03		
12:37-13:13		Relocation unto a new face (15m away)
13:13-13:19		
13:19-15:50		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

<u>Daily Activity Records</u>

Project Type: Shopping mall construction

Date of Study: 13-07-06

Subcontractor:

Task Group: B

Task execution: **Plastering**

Crew Size: 14 (5A, 9L)

Start Work: 07:28

End Work: 17:23

Crew Output: **125.52 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:28-08:23		Preparing mortar
08:23-11:29		
12:31-17:23		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

<u>**Daily Activity Records**</u>

Project Type: Shopping mall construction

Date of Study: 14-07-06

Subcontractor: Ohlorst & Partners

Task Group: A

Task execution: **Plastering**

Crew Size: 14 (5A, 9L)

Start Work: 07:27

End Work: 15:03

Crew Output: 116**sq metres**

Relaxation allowance: 26%

Break times:

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:27-07:45		Preparing mortar
07:45-09:00		
09:19-11:58		
12:33-15:03		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 14-07-06

Subcontractor:

Task Group: B

Task execution: **Plastering**

Crew Size: 13 (5A, 8L)

Start Work: 08:21

End Work: 17:00

Crew Output: 98 **sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
08:21-10:00		Setting up scaffold and preparing mortar
10:00-13:15		
13:49-17:00		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 17-07-06

Subcontractor: Ohlorst & Partners

Task Group: A

Task execution: **Plastering**

Crew Size: 4 (2A, 2L)

Start Work: 07:14

End Work: 15:44

Crew Output: **25sq metres**

Relaxation allowance: 29%

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:14 - 07:37		Preparing mortar
07:37-09:00		
09:26-12:00		
12:36-15:44		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	3
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**29**

Daily Activity Records

Project Type: Shopping mall construction

Date of Study: 17-07-06

Subcontractor:

Name of Crew: B

Task execution: **Plastering**

Crew Size: 16 (6A, 10L)

Start Work: 07:37

End Work: 17:23

Crew Output: **89 sq metres**

Relaxation allowance: 26%

Plaster Thickness: 15mm

Productive time/hrs	**Idle time/hrs**	**Remarks**
07:37-09:05		Cleaning up, preparing mortar and setting up
09:05-09:27		
09:27-10:22		Arranging shutters on scaffold
10:22-12:14		
13:26-17:23		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	12
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	2
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**26**

APPENDIX E:

DAILY ACTIVITY RECORDS ON TILING

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 19-07-06

Task Group: I

Main Contractor: G.I.P Builders (pty) ltd

Task execution: **Tiling-1**

Crew Size: 2 Tilers

Start Work: 07:39

End Work: 16:43

Crew Output: 20 sq metres / 222 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
07:39-11:13		
11:13-11-18		Crew were allocated a new working location
11:18-12:00		
12:51-16:43		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 19-07-06

Task Group: J

Main Contractor: G.I.P Builders (pty) ltd

Task execution: **Tiling-2**

Crew Size: (2) 1-Tiler, 1-Helper

Start Work: 11:39

End Work: 16:41

Crew Output: 17.5sq metres / 194 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
11:39-12:00		
12:32-16:41		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 19-07-06

Task Group: K

Main Contractor: G.I.P Builders (pty) ltd

Task execution: **Tiling-3**

Crew Size: (2) 1- Tilers, 1-Helper

Start Work: 14:16

End Work: 16:36

Crew Output: 5.2 sq metres / 58 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
14:16-16:36		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 20-07-06

Task Group: J

Main Contractor: G.I.P Builders (pty) ltd

Task execution: **Tiling-2**

Crew Size: (2) 1-Tiler, 1-Helper

Start Work: 08:39

End Work: 16:32

Crew Output: 10.2sq metres / 113 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	Idle time/hrs	Remarks
08:39-11:30		
11:30-12:00		
	12:30-13:25	No tiles on site. Waiting for tiles
	13:25-14:20	Shortage of straps to complete task; waiting for foreman to allocate new location to start tiling
14:20-14:48		Moved to new allocation due to lack of straps
14:48-16:32		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 20-07-06

Task Group: I

Main Contractor: G.I.P Builders (pty) ltd

Task execution: **Tiling-1**

Crew Size: 2 Tilers

Start Work: 08:48

End Work: 16:45

Crew Output: 8.4 sq metres / 93 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:48-11:07		
	11:07-12:00	No tiles available
	12:30-13:25	No tiles available
	13:25-14:20	Tiles available but waiting for instructions from foreman before task execution can continue
	14:20-15:39	Foreman orders for re-work on sections of previous days activity
15:39-16:45		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 20-07-06

Task Group: K

Main Contractor: G.I.P Builders (pty) ltd

Task execution: **Tiling-3**

Crew Size: (2) 1- Tilers, 1-Helper

Start Work: 08:50

End Work: 16:36

Crew Output: 8.6 sq metres / 96 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:50-09:23		
	09:23-09:54	Obstructed by plumbing work
09:54-10:48		
	10:48-12:00	Shortage of tiles and straps
	12:30-13:25	Shortage of tiles and straps
	13:25-14:20	No straps available; waiting for Foreman to be relocated to start task execution
14:20-14:27		Moved to new location due to lack of straps
14:27-16:36		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 20-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: N

Task execution: **Tiling-4**

Crew Size: (2) 1-Tiler, 1-Helper

Start Work: 09:57

End Work: 17:16

Crew Output: 12sq metres / 133 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
09:57-10:13		Cleaning up working surface
	10:13-12:00	Crew waiting for tiles to start work
	12:30-13:20	No tiles on site. Waiting for tiles
13:20-13:29		Tiles are available. Relocates to new work place due to the realization of a crack in some section of the wall
13:29-13:40		Cleaning up working surface of new location
13:40-15:05		
15:05-15:37		Removal of some section of tiles already laid; this was due to misinformation (straps) on the part of Site Foreman
15:37-17:16		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 21-07-06

Contractor: G.I.P Builders (pty) ltd

Task Group: N

Task execution: **Tiling-4**

Crew Size: (2) 1-Tiler, 1-Helper

Start Work: 07:29

End Work: -13:07

Crew Output: 11.4sq metres / 127 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
07:29-10:25		Re-work on previous days work; Floor tiles disturbed due to someone walking on them whilst not dry
10:25-10:31		Moving to new location to start work
10:31-10:36		Setting up
11:08-13:07		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Nb: This day was ‘pay day’; hence, it was only half day work

<u>Daily Activity Records</u>

Project Type: Office Block & Retail Center construction

Date of Study: 21-07-06

Contractor: G.I.P Builders (pty) ltd

Task Group: I

Task execution: **Tiling-1**

Crew Size: 2 (1 tiler, 1 helper)

Start Work: 08:07

End Work: 13:02

Crew Output: 6.6 sq metres / 74 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:07-08:26		Mixing adhesive
08:26-13:02		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Nb: This day was ‘pay day’; hence, it was only half day work

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 21-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: J

Task execution: **Tiling-2**

Crew Size: (2) 1-Tiler, 1-Helper

Start Work: 08:19

End Work: 13:00

Crew Output: 10.2sq metres / 114 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:19-08:23		Cleaning up and mixing adhesive
08:23-09:31		
09:31-09:40		Relocation to new face
09:40-13:00		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Nb: This day was ‘pay day’; hence, it was only half day work

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 21-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: K

Task execution: **Tiling-3**

Crew Size: (2) 1- Tilers, 1-Helper

Start Work: 08:46

End Work: 13:00

Crew Output: 1.3 sq metres / 15 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:46-09:09		Cleaning up surface and mixing adhesive
09:09-13:00		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Nb: Tiler was fixing straps and mostly cutting tiles into smaller pieces to fit corners and edges. Tiling 1-3 shared the same tile cutter.

Nb: This day was ‘pay day’; hence, it was only half day work

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 24-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: I

Task execution: **Tiling-1**

Crew Size: 2 (1 tiler, 1 helper)

Start Work: 08:43

End Work: 16:34

Crew Output: 10.7sq metres / 119 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
08:43-08:57		Cleaning up working surface
08:57-10:05		
10:05-10:40		Moving to new location
10:40-10:52		Cleaning up surface
10:52-12:07		
	12:30-13:57	At accident scene; playing cards
13:57-16:34		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 24-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: N

Task execution: **Tiling-4**

Crew Size: (3) 2-Tilers, 1-Helper

Start Work: 09:27

End Work: 16:50

Crew Output: 22.8sq metres / 254 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
09:27-09:49		Setting up
09:49-12:37		
	12:37-13:55	At accident scene
13:55-16:50		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 24-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: J

Task execution: **Tiling-2**

Crew Size: (2) 1-Tiler, 1-Helper

Start Work: 10:14

End Work: 16:25

Crew Output: 9.9 metres / 111 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
10:14-12:03		
	12:30-13:57	At accident scene, playing cards
13:57-15:39		
15:39-15:44		Moved to a new location
15:44-16:25		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 24-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: K

Task execution: **Tiling-3**

Crew Size: (2) 1- Tilers, 1-Helper

Start Work: 10:23

End Work: 16:30

Crew Output: 11.9 sq metres / 132 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
10:23-12:00		
	12:30-13:57	At accident scene; playing cards
13:57-14:10		
14:10-16:30		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

Daily Activity Records

Project Type: Office Block & Retail Center construction

Date of Study: 27-07-06

Main Contractor: G.I.P Builders (pty) ltd

Task Group: N

Task execution: **Tiling-4**

Crew Size: (3) 2-Tilers, 1-Helper

Start Work: 07:33

End Work: 17:17

Crew Output: 25.7sq metres / 285 tiles

Relaxation allowance: 13%

Tile dimension: 300mm * 300mm

Working time/hrs	**Idle time/hrs**	**Remarks**
07:33-07:48		Cleaning up working surface and mixing mortar
07:48-13:00		
13:42-17-17		

Item	Situation	Relaxation Allowance
1	Fixed allowance (**male**)	8
2	Effort and dexterity	1
3	Posture	2
4	Fatigue	2
5	Visual	0
6	Noise	0
7	Concentration	0
8	Working Conditions	0
9	Total (%)	**13**

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