

THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

Improving productivity in construction: a contractor perspective

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a contractor perspective
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*If you always do
what you always did
you will always get
what you always got*

Susan Jeffries

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Abstract

Improving productivity in construction has been a lengthy battle. Several debates, articles, reports and books have acknowledged that productivity in construction must be improved. Numerous theoretical and practical solutions to improve productivity have been developed over time both in academia and in practise. A problem with developing theories on how to improve productivity is that there is no generally accepted definition of the term. Productivity has different meanings for different individuals, dependent on context, background and profession. It is therefore likely that suggestions on how to improve productivity will be interpreted differently. In order to improve productivity in construction, the concept itself must first be explored from a context specific perspective. Throughout this thesis it is the production managers' views that are under scrutiny.

The aim of this thesis is to identify factors that influence productivity in construction and to explore the production managers' views on potential improvements of productivity. Various aspects of productivity are presented and synthesised into a model where inputs are related to outputs through a transformation process. Resources, costs for the use of resources, and the value added in the process are factors in this model.

The thesis is based on three papers, each focusing on its own research question. Paper I presents the difficulties of evaluating productivity by exploring the multiple usages of the term in construction. Paper II further examines productivity by analysing what views production managers have concerning their firms' productivity improvements by reducing the unnecessary use of resources. Paper III explores what views production managers have concerning their roles when productivity is improved through increasing standardisation by exploring the relationship between the production managers' need for freedom in their construction projects and the firms' need for standards that improve productivity.

The main findings confirm that resources, costs for the use of resources, and the value added are terms that need to be considered when productivity is to be improved from a production manager perspective. Conclusions are drawn that production managers are not averse to implementing standards or reducing the use of resources to improve productivity. Instead, the short-term cost focused approach prevailing in the construction industry hinders the managers from finding and establishing standards that can improve project productivity in their project organisations.

Keywords: construction industry, contractor organisations, production manager perspective, productivity, transformation process, use of resources, value added

Appended papers

This thesis is based on the following papers:

Paper I

Polesie, P. & Felderhoff, M. (2009) Exploring the Complexity of Productivity in Construction. *Proceeding of 5th Nordic Conference on Construction Economics and Organisation*, 61-70 Reykjavik University. Reykjavik University.

Paper II

Polesie, P. (2011) Reducing the use of resources in construction. *Submitted to Journal for review*.

Paper III

Polesie, P. (2011) Freedom versus standardisation in the work role of production managers in construction. *Submitted to Journal for review*

Additional publications

Felderhoff, M. & Polesie, P. (2009). Cost inefficiencies in construction. *Proceeding of 5th Nordic Conference on Construction Economics and Organisation*. Reykjavík, Iceland.

Polesie, P. & Frödell, M. & Josephson, P-E (2009). Implementing standardisation in medium-sized construction firms: facilitating site managers' feeling of freedom through bottom-up approach. *Proceedings for the 17th Annual Conference of the International Group for Lean Construction*. Taipei, Taiwan.

Josephson, P-E & Polesie, P. & Frödell, M. (2009). Understanding resources waste reduction priorities in Swedish construction. *Proceedings of CIB Joint International Symposium 2009: Construction Facing Worldwide Challenges*. Dubrovnik, Croatia.

Polesie, P. (2010). What do managers mean by saying "I appreciate the freedom on site". *Proceedings of CIB 2010 World Congress, CIB Publication 359*. Salford, United Kingdom.

Polesie, P. (2010). Lean construction philosophy and individual freedom. *Proceedings for the 18th Annual Conference of the International Group for Lean Construction*. Haifa, Israel.

Acknowledgement

It is not always easy to write. Writing is a learning process. All learning processes are like journeys. No journey is ever altogether easy. I don't think they should be. A driving force to undertake a journey is, at least for me, the challenge of being exposed to new impressions.

Previous journeys have made me realise that one often needs guidance in order to reach a destination. Different journeys are undertaken with different guides. For some journey a sea chart or a battered Lonely Planet book provides the guidance. When writing a thesis the guide is often a person who has previously ventured on a similar journey. It needs to be someone who is both willing and able to help and assist when doubts arise. But this is not all that is needed from a guide when one sets out on such a journey. Sometimes the guide must let you learn through your own mistakes and let you navigate through murky waters without interrupting with clever thoughts based on their own experiences.

Per-Erik Josephson has, in the role of supervisor, been the guide through the journey of writing this thesis. He has realised my need for freedom and allowed me to set my own course in reaching the predetermined goal. Thereafter he has patiently given me the time that I have needed to conceptualise the subject matter from a more philosophical point of view. For this I am grateful.

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1. Introduction

The importance of improving productivity in a construction context has long been maintained (Koskela, 2000, Murray and Langford, 2003, Bröchner, 2011). The reasons are manifold, one example being the increasing cost of the use of resources, which has caused the prices in construction to go up (SOU, 2002:115). Yet, despite the importance given to productivity what it consists of and how to increase it has not so far been clearly established. Various interpretations of the term exist. Indeed how the term is understood and consequently the reasoning behind how to improve productivity may be context-dependent. It is therefore questionable whether productivity improvements can be found that are useful in all construction contexts.

Many argue that productivity is an important variable for the economy of production activities (Tucker, 1986, Drucker, 1991, Singh et al., 2000). It has become one of the most prominent factors for organisational performance and success (Jackson, 2000, Singh et al., 2000, Tangen, 2003, Jonsson, 2005). For example Prokopenko (1987, p.6) argues, *“At present it would not be wrong to state that productivity is the only important world-wide source of real economic growth, social progress and improved standards of living”*. Yet, at the same time others suggest that the concept has not been fully explored and that productivity measures have not yet been well established (e.g. Tangen, 2004, Crawford and Vogl, 2006, Forsberg, 2008). It has further been suggested that there are differences in the definition of the term inside organisations, since individuals have different perceptions of productivity, depending on their background and profession (cf. Albriktsen and Førsund, 1990, Johnston and Jones, 2004). It has been claimed that associated terms often have to be used in order to interpret productivity in comparable ways, e.g. performance, profitability, inputs, outputs, efficiency, effectiveness, resources, cost for the use of resources, and value added are some of the terms that are usually connected to productivity. Further, the various definitions of these terms are likely to cause misunderstandings in the conduct of daily activities (Tangen, 2004). Productivity being an important term this inconsistency in definitions is problematic. How can productivity be one of the most important organisational measures if all actors do not interpret it in the same way?

It is clear that the construction industry faces many challenges in their strive to improve productivity. Various reports and articles have long criticised the industry for low productivity. They have reasoned around this problem and found numerous ways to solve it (cf. Murray and Langford, 2003, Bröchner, 2011). Specifically in industrialised countries voices have been raised saying that the construction industry has rising costs, poor quality, and low productivity growth (cf. Koskela, 2000, p. 131). Concern has been expressed globally over why the many changes suggested by the reports (e.g. Latham, 1994, SOU, 1997:177, Egan, 1998, SOU, 2002:115, SOU, 2009:6) have not been implemented to a greater extent (cf. Fernie et al., 2006).

Often the changes suggested in reports are based on political agendas and current trends (Bröchner, 2011). Examples are improved productivity through building stronger teams as suggested by Latham (1994) or improving productivity through implementing ‘lean construction’ as suggested by Egan (1998). The reports often present a top down perspective and suggest solutions without considering their

implications from an on-site point of view. This may partly explain the lack of willingness to change in line with the solutions presented in the reports.

In contrast to the above, production managers have been chosen as the point of departure in the empirical study for this thesis. They are viewed as key players for project success (Styhre, 2006); and they work autonomously when managing an on-site project organisation (Eccles, 1982). The heavy responsibilities they are given require individuals that are capable of making hard choices, but also given the space to do so. Their comparably low job satisfaction as reported by Styhre and Josephson (2006) may well indicate that the balance in their work role is already uneven and that they are stuck in the middle between organisational control on one hand and their responsibility to achieve project success on the other (Styhre and Josephson, 2006).

Since Production managers play such important roles, efforts by top management to improve productivity, without anchoring them with the production managers might run the risk of negatively affecting the production managers' motivation (Styhre and Josephson, 2006). If, due to actions taken to improve productivity, production managers' motivation decreases to such an extent that they choose to leave their organisation, as has been suggested by Mustapha and Naoum (1998), both productivity and the firm's competitive advantages could decrease. Therefore, many aspects of productivity improvement need to be explored, questioned and further discussed before they are implemented. Alternate points of view may be required in order to identify how productivity can be improved without simultaneously reducing employee motivation. Production managers' views on productivity are scrutinised from two different angles; productivity improvement by reducing the use of resources, and productivity improvement by increasing standardisation. Both approaches use a middle-management, bottom-up perspective in contractor organisations. Such an approach has so far not been used in construction.

In this thesis, productivity will be explored from a construction contractor perspective. By initially describing some terms that are often used in conjunction with productivity (appended paper I) factors that influence productivity are identified. To explore production managers' view on potential improvements of productivity two of these factors are further explored from production managers' views (appended paper II and III).

1.1 Aim of the thesis

The aim of this thesis is *to identify factors that influence productivity in construction and to explore production managers' views of potential improvements of productivity.*

In order to achieve this, three research questions have been formulated. The research questions are presented in the three articles that are attached to this thesis.

- What definitions are in focus when the term productivity is used? (Appended paper I)
- What views do production managers have concerning their firms' attempts to reduce the unnecessary use of resources? (Appended paper II)
- What views do production managers have concerning increasing standardisation? What is the relationship between the production managers' need for freedom in their construction projects and the firms' need for standardising to improve productivity? (Appended paper III)

1.2 Scope of the thesis

The scope of this thesis is confined to previously established definitions and ideas of productivity. Well-known ways of improving productivity have been explored in a construction context. Due to the large literature base, the thesis will deal only with a limited selection of the measures that could be taken to improve productivity in construction projects. Primarily construction related literature has been reviewed, suggestions for productivity improvement from other fields of research lie outside the scope of this thesis.

Since the concept of productivity is so broad, one best way for an organisation to improve might not exist. Given this, the methods chosen to improve productivity may well vary from one organisation to another. The chosen organisations will thereby affect the view of what productivity means and how it may be improved. The scope of the study is confined to three specific contractor organisations. The views presented by the fifteen production managers' (five from each of the three companies) that have participated in the study may well be representative of other organisations, but it is outside the scope of the thesis to confirm this.

In conjunction with practical limitations, the empirical data gathered for the study is geographically limited to the Gothenburg region. Furthermore, since the role of production managers may be defined differently elsewhere, the focus on Swedish the construction industry may limit comparisons to conditions in other regions.

1.3 Structure of the thesis

The first chapter gives an introduction to the study. It presents the problem at hand and the importance of exploring productivity from the production manager's perspective. The aim and the three research questions are presented and the scope of the thesis is described.

The second chapter gives the background to the study and further describes the problem at hand by relating how important the demand for improved productivity has become for the construction industry. Also, the important role that production managers have in construction is presented to further motivate the focus on their role throughout the thesis.

In the third chapter the theoretical framework for the study is presented. The first part of the theoretical framework describes the development of productivity and elaborates on related terms. Resources, the cost of the use of resources and the value added are identified as closely related to productivity. The second part of the theoretical framework describes, from a construction perspective, means of improving productivity by reducing the use of resources and standardise construction projects.

The fourth chapter presents the theoretical framework used when developing the study. The methodological considerations are described from a theoretical perspective. The method used to gather empirical data is presented together with a description on how the data has been analysed.

Chapter five summarises the appended papers. The purpose and findings of each paper are described together with reflections on the conclusions that have been drawn from them.

In chapter six the findings from the different papers of the thesis are combined for a discussion on productivity. In particular the connection between resources, the cost of the use of resources, and productivity is examined from time and money perspectives.

In chapter seven conclusions from the study are drawn and the research questions are answered. The limitations of the study and reflections on further research are presented.

2. Swedish construction industry and productivity

From a global perspective, construction is one of the largest industries in the world (Tucker, 1986, Dainty et al., 2005, Abdel-Wahab et al., 2008). It plays an important role in industrialised nations (Koskela, 2000). In Sweden, the construction industry is comprised of facility management, construction material suppliers, architect firms, construction, construction contractors, sub-contractors (specialists) and construction-related consultancies. In 2008, 8% (approx. 77.000) of all registered companies in Sweden were construction-related, industry turnover was close to 100 billion Euros and approximately 11% of the Swedish workforce were active in the industry (Swedish Construction Federation, 2009). In financial terms the total investment in the Swedish construction market was about 26 billion Euros in 2008, representing approximately 8% of the Swedish GDP (*ibid*).

2.1 The construction industry is accused of low productivity

Many construction reports have in unison presented a gloomy image of the construction industry (Murray and Langford, 2003, Bröchner, 2011). The construction industry has in various reports been characterised as particularly slow to react to recommendations and to societal changes (Dulaimi et al., 2002, Borgbrant, 2003, Hampson and Brandon, 2004, Jonsson, 2005). Frequently the industry is portrayed as resistant to change and accused of not having implemented adequate numbers of solutions to improve its low productivity (Latham, 1994, Murray and Langford, 2003). Examples from the UK are the Latham report, *Constructing the Team*, from 1994, the Egan report, *Rethink Construction*, from 1998 and the Construction Excellence report, *Be Valuable*, from 2005. In a Swedish context these can to some extent be compared with e.g. *Skärpning Gubbar* (SOU, 2002:115) and *Sega Gubbar* (SOU, 2009:6). In these reports, three particular aspects of the industry have been claimed to obstruct productivity improvements.

2.1.1 A project-based industry

The construction industry has always been project based and highly project oriented. The development of the construction industry has been to merge smaller local companies into larger organisations (Flanagan et al., 2007). Accordingly, construction projects have become increasingly self-sustaining with few links to top management or to other projects (Anheim, 2003).

Today, temporary organisations are set up for every project (Eccles, 1982, Egan, 1998). A main contractor sets up project-specific multi-organisations through collaboration with sub-contractors and suppliers (Wild, 2002). Therefore, projects in the construction industry are characterised by a heavy reliance on outsourcing (Dubois and Gadde, 2000, Humphreys et al., 2003). The sub-contractors typically contribute up to 90% of the total work (Gadde and Håkansson, 2001). A project organisation may involve hundreds of different companies (Dainty et al., 2005). The many professional categories involved are characterised by individual interests and goals (Dubois and Gadde, 2000). The profusion of actors in construction projects has led to focus being put on single transactions and the cost of specific project activities (cf. Gadde and Håkansson, 2001, Samuelsson, 2006). This has increased focus on transactional rather than relational exchanges between the trades in the project

organisation (Fearne and Fowler, 2006). It has been claimed that this further increases fragmentation among the contractors (Simu, 2009), a fragmentation portrayed as a reason for why the construction industry is seen as uncertain, complex and having low productivity (Latham, 1994, Murray, 2003, Jonsson, 2005).

The project-orientation of the industry has contributed to the development of a decentralised power structure, where production managers play key roles in project organisations (SOU, 2002:115, Styhre and Josephson, 2006). In present-day construction projects managers are forced to deal with a constant flow of actors during the project, as only a few areas of expertise are needed at any given time. Commonly, only a few of the actors present at the beginning of the project participate all the way to the end (Dubois and Gadde, 2000). Reasons for this, among others, are simultaneous processes, complex structures, rules, regulations, several different actors involved, short time-spans and varying technical solutions (cf. Gadde and Håkansson, 2001, Treloar et al., 2003).

2.1.2 No accepted measures to compare productivity

Koskela (2000), Urgan (2006) and Forsberg (2008) argue that there is little agreement as to how to measure and what to measure in order to compare productivity between projects and companies in the construction industry. This, lack of comparability, they maintain, hinders construction organisations from developing. Today, construction companies create their own methods to measure productivity that are aligned with company values and practice (Forsberg, 2008). These are commonly focused on time, cost and quality (Eccles, 1982, Winch, 2002). They are often created for supervising performance or internal project success (Winch, 2002) and rarely shown to the public or made available to other firms for comparative purposes. Instead, economic indicators such as profit, revenues and costs are displayed (SOU, 2009:6). These shed light on only parts of the bigger organisational picture not productivity in itself.

When it comes to measuring project performance, Koskela (2000) has noted that construction management is centred around 'the transformation process', the process of changing input resources into output resources. The main point that Koskela brings up as a hindrance to finding the most effective way to transform inputs to outputs in construction is that the actors in the industry regard the transformation process of each project as unique. Transfer of knowledge between projects may therefore be perceived as unnecessary among the actors, thus being difficult to implement. The perceived uniqueness could also affect the perceived importance of finding means of measuring and comparing productivity.

Koskela and Vrijhoef (2001) also suggest that since the managers' skill is not applied in all phases of the construction project, it adds to the variability that the industry is known for. They claim that this might also lead to increased uncertainty about outcomes for the contractor and the customer. Urgan (2006) also suggested that variability in processes may cause variation in output, which causes even more uncertainty for the customer and renders the usefulness of measuring productivity in projects more questionable. This may partly explain why construction projects are often considered to have low productivity. In order to improve, Urgan (2006) suggests that effective measures such as process documentation should in a greater degree be used to compare productivity in construction projects.

Koskela and Vrijhoef (2001, p.202) claim that managers are encouraged to focus on tackling upcoming uncertainties and interdependence - which they assert produces “*a climate for endemic crises, which becomes self-perpetuating*” - instead of focusing on the project at hand. The above arguments make it clear that the production managers’ situation is not easy. They have to deal with a number of both upcoming and well-known problems, and on the same time act as leaders and managers. It may be time to adopt their perspective on what should be done to increase productivity.

2.1.3 Focus on short-term project profit

Construction project organisations are often characterised by uniqueness, a decentralised power structure and few control functions. To deal with this reality it has been suggested that the construction industry has been forced to maintain a heavy focus on project cost and price (Koskela, 2000). This burden is transferred to the production managers, who act as company representatives on-site (Styhre, 2007). However, focus on project cost may encourage the project leader to emphasise effectiveness, thereby directing attention on reducing cost and the time used for each given task instead of on increasing productivity (Fearne and Fowler, 2006).

Such a narrow, short-term focus could lead to subcontractors focusing on doing their part as well as possible instead of taking a holistic view of increased project productivity (Gadde and Håkansson, 2001). A heavy focus on cost has also been suggested to lead to a focus on short-term cost cuts or saving money for the project, instead of looking at the process as such, with focus on its ability to add value to the organisation or giving the customers what they want (Womack and Jones, 2003).

The focus on short-term, project-specific cost savings could also increase the tendency among the suppliers and subcontractors to focus on reducing their costs and increasing their profit margins as much as possible (opportunistic approach), without considering what would be better for the whole project and for cooperation in the long run (Gadde and Håkansson, 2001, Simu, 2009). In practice, it could thereby be difficult to optimise value and not minimise price since higher value is argued to be best achieved through the cooperative efforts of the contractor and the supplier (Wong et al., 2000).

2.2 The role of production managers in contractor organisations

As the above section shows, the construction industry is complicated. Contractor organisations are highly decentralised (cf. Barber et al., 1999). Projects are often geographically dispersed, and are afforded a high degree of autonomy (Simu, 2009).

Much responsibility is thereby laid on the production manager’s shoulders. They play central roles in construction projects (Winch, 2002). Styhre and Josephson (2006) maintain that production managers run their project organisations ‘*as they see fit*’. They are entrusted with ‘freedom’ to develop their own approaches to running their projects. This has resulted in production managers making decisions on e.g. the number of specialists that are needed in a project (Egan, 1998); the availability of labour and creating the team (Chan and Kaka, 2007); labour-related resources such as tools and equipment (Ballard and Howell, 1998, Fearne and Fowler, 2006); relations to customers (Kärnä et al., 2009); relations to suppliers (Vrijhoef and Koskela, 2000, Gadde and Håkansson, 2001); construction components; new regulations (Winch, 2002); and weather conditions (Josephson and Saukkoriipi, 2005), and in dealing with the ambiguity in the priorities of top management (Djebarni, 1996) according their

own capacity and judgment. It has even been maintained that the final project result to a great extent depends on how the production managers have chosen to confront these problems (cf. Forsberg, 2008). They in all probability will have considerable effect on project productivity. Simu (2009) illustrates their role by describing the production managers as being:

“...responsible for making the construction or production parts of the project succeed, with legal responsibility for the work environment and built environment, financial responsibility representing the main contractor, quality and functional objective set in the contractual document and responsibility for keeping to the timeframes specified in the contract” (ibid, p.5).

Djebarni (1996) and Simu (2009) describe production managers as individuals who are in charge of on-site operations. They are responsible for the on-site activities during the production phase. In Sweden, they report to top management in their firm and deal with suppliers and project employees (Styhre and Josephson, 2006). They are suggested to be the “*jack-of-all-trades*” (Styhre, 2007 p.523) and simultaneously “*stuck in the middle*” between top managers on one hand and construction workers on the other (Styhre and Josephson, 2006). It has been maintained that production managers carry the responsibility of middle managers, but that their authority in their projects is more like that of a CEO (Davidson and Sutherland, 1992). Djebarni (1996) argues that production managers in construction play crucial roles, for both organisational and project success. He suggests that the contractors’ reputation is built on-site and that it is there that cash flow is generated and problems circumvented (*ibid*, p. 281).

2.2.1 Individual approaches to similar problems

The autonomy enjoyed by production managers leads to individual approaches that differ across projects. What a production manager expects a contractor to do on one project might not be close to similar to what is expected in another project with another production manager, even in the same organisation. This is a reason for misunderstandings and may at worst lead to conflicts (Djebarni, 1996). Dissimilar approaches to similar construction projects have been suggested to cause variability (Thomas et al., 2002), which leads to variation in productivity (Ungan, 2006). Non-standardised approaches to similar problems often also lead to the unnecessary use of resources (Thomas et al., 2002, Womack and Jones, 2003, Liker, 2004, Craig and Sommerville, 2006).

The production managers’ background, experience and style might therefore have considerable effect on the final product (Styhre and Josephson, 2006), the final financial result, customer satisfaction and thereby the reputation of the contractor organisation (cf. Josephson and Saukkoriipi, 2005, Kärnä et al., 2009, Simu, 2009). To avoid variations in results, it could be argued that production managers should adopt standardised approaches. A contrary view is that production managers enjoy to having the freedom to run projects their own way. It has even been suggested that the freedom they enjoy may be what really motivates them (Mustapha and Naoum, 1998), and that they require freedom in their work roles to be able to find their way in their complex realities (Djebarni, 1996). Since production managers play central roles, their motivation and driving force might need to be carefully considered by their firms.

If they are, due to freedom, satisfied in their work role it may be unwise to standardise processes.

The question how to improve productivity in construction is a complex matter. Many parameters must be explored in order to come up with an answer. Initially, factors that influence productivity must be identified and described before the question how productivity can be improved in construction can be answered. Then these improvements must be explored from a production manager's perspective to make sure that these do not affect the managers' motivation. Their views on improving productivity have not yet been explored.

3. Frame of reference

This chapter describes the theoretical framework used for addressing the aim and the research questions. In the first part (sections 3.1 - 3.2) the complexity of productivity is described. Here definitions and related issues that are in focus when productivity is discussed in the literature are presented. Factors that influence productivity in construction are described (section 3.3) to establish the basis used in the second part. The second part (section 3.4) presents the two chosen potential methods for improving productivity in projects from a construction contractor perspective. These have been further explored in the empirical data (Paper II and Paper III).

3.1 Productivity

Different industries, cultures and individuals use the term productivity in different ways (Johnston and Jones, 2004, Crawford and Vogl, 2006). An example of the diverse definitions is presented by Ganesan (1984) who categorises five levels of productivity in construction: national economy, total construction industry, construction markets, sub sectors, project conception and individuals own views. He suggests that each of these categories requires different measures and definitions.

The various definitions of the term productivity leads to misunderstandings and uncertainty (Johnston and Jones, 2004). It is clear that comparing national economy, the construction industry, construction markets and subsectors in construction, individual construction companies, sections within the companies and even individuals to other individuals within the project organisations in one measure is close to impossible (cf. Ganesan, 1984, Crawford and Vogl, 2006). Naturally the different levels require different measures. Difficulties in using the same term when measuring at all levels are accentuated when it is recognised that concepts are often also understood differently among employees, depending on their background and profession (Lawrence and Lorsch, 1967). Considering the various meanings given to productivity, using it as a significant indicator of organisational success is thereby made difficult and even debatable (cf. Tucker, 1986).

In the following the complexity and diversity of the term will be presented and some other terms that are closely related to productivity are identified.

3.1.1 A historic perspective

One of the first documented occurrences of the term productivity is from François Quesnay who used it in the French *Journal de l'Agriculture* published in 1766 (Tangen, 2005 p. 35). Productivity was then associated with the productive capacity of land in an agricultural context (Pritchard, 1995, Tangen, 2005). The amount of crops from the land remained a valid productivity measure until the industrial revolution, where general economic welfare became less dependent on the productive capacity of land. This caused the focus on productivity to change gradually towards measures of economic growth and efforts made by labor (Pritchard, 2004, Tangen, 2004).

After the industrial revolution, productivity became related to the production process; the transformation of inputs to more valuable outputs (Ganesan, 1984, Grubbström,

1995, Jackson, 2000). It is this transformation system (illustrated in Figure 3.1) that has come to be the foundation of various theoretical models of how to measure and define productivity throughout the 20th century (Jackson, 2000, Koskela, 2000, Tangen, 2002). During the process of developing the models productivity came to be recognised as an important organisational measure that can be used for comparing performance (Sink and Tuttle, 1989, Ghobadian and Husband, 1990, Pritchard, 1995).

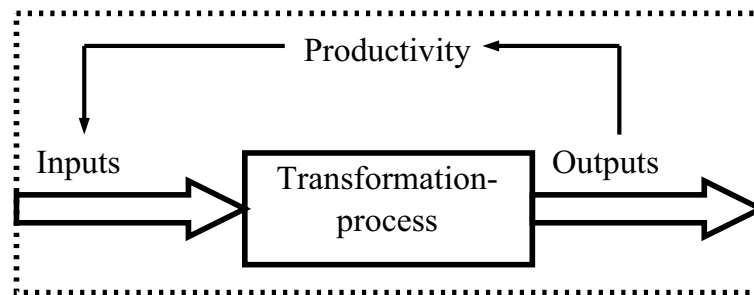


Figure 3.1. *The basic view on productivity maintained from the industrial revolution (developed from Agrell and Wikner, 1996).*

According to Rämö (2002), it was Taylor’s ideas (1911) that led to a “revolution in manufacturing” and to the rapid development of facilities for mass production. In Taylor’s theories productivity was closely related to the efficiency of labour and the importance of human capital (Maani, 1989, Drucker, 1991). The main definition of productivity for Taylor was the value of goods manufactured divided by the amount of input labour (Japanese Productivity Center 1958; Jackson, 2000). This is still a leading measure and is often used today.

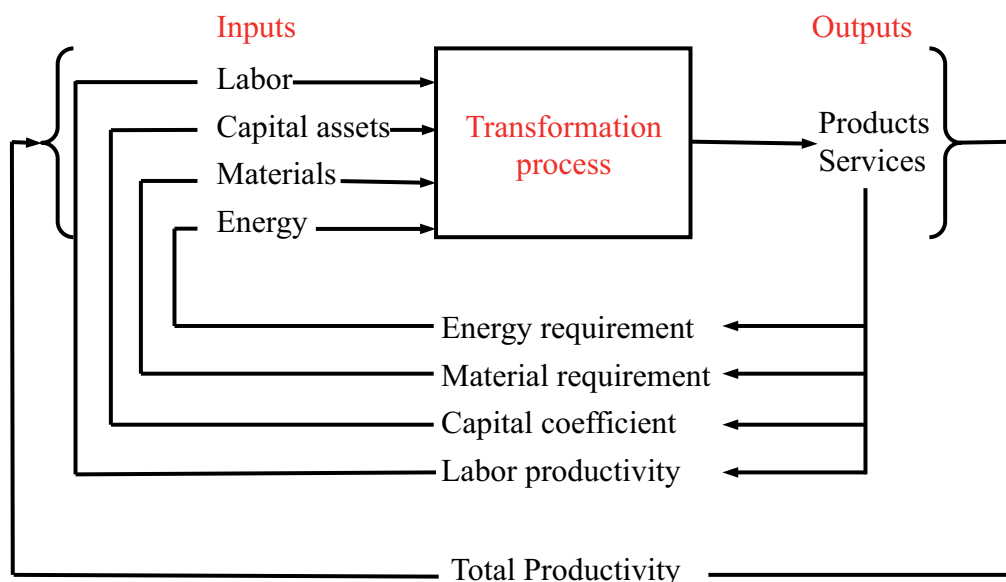


Figure 3.2. *The difference between single factor productivity measures and total productivity measures (developed from Kurosawa, 1991).*

In the late 1970s, behavioural scientists and organisational psychologists began to focus on productivity (Pritchard, 1995). Their aim was to understand the driving forces behind increasing productivity. To elaborate on productivity behavioural scientists extended the term to include more than what had been included by

manufacturing organisations and shifted from the single factor productivity that had been used, where main focus was on labour efficiency, to a broader view of total productivity (Ganesan, 1984). Prokopenko (1987) illustrates the importance of looking at a broader view of productivity by claiming that labour intensity only induces excess effort and is no more than increasing the speed of work. The focus on single-factor productivity, where labour intensity is the major input factor, therefore changed to include more input factors such as capital, land, materials and energy (cf. Kurosawa, 1991, Stainer, 1995) (illustrated in Figure 3.2). This approach has become known as total factor productivity (e.g. Jackson, 2000, Tangen, 2004).

3.1.2 Productivity definitions

As previously noted there are many definitions of productivity. These can be categorised in a number of ways. One is the distinction between single, multi and total factor productivity that has been described above. Another is the distinction between mathematical and verbal definitions (Tangen, 2004). Verbal definitions are useful when describing strategic objectives, while mathematical measures are useful as performance indicators when productivity is to be improved (*ibid*). A third distinction is that between physical and monetary units (Misterec et al., 1993). Table 3.1 gives an overview of the different definitions of productivity that have been developed and used over the years.

Table 3.1. *Examples of how productivity has been used through time. Developed from Tangen (2004, p. 35).*

<i>Reference</i>	<i>Definition</i>
Litré (1883)	Productivity = faculty to produce
Japan Productivity Center (1958)	Productivity is what man can accomplish with material, capital and technology. Productivity is mainly a matter of personal behaviour. It is the attitude that we must continuously improve ourselves and the things around us.
Sink (1985)	Productivity is simply the relation between the outputs generated from a system and the inputs provided to create those outputs. Inputs in the general form of labor (human resources), capital (physical and financial capital assets), energy, materials, and data are brought into a system. These resources are transformed into outputs (goods and services). Productivity is the relation of the amount produced by a given system during a given period of time, and the quantity of resources consumed to create or produce these outputs over the same period of time.
Prokopenko (1987)	Productivity is the effective and efficient utilisation of all resources; labor, plant and materials.
Sink and Tuttle (1989)	Productivity = actual output / expected resources used
Oglesby et al. (1989)	Productivity has a variety of meanings. In national development statistics it is commonly stated as constant in-place value divided by inputs, such as work-hours. For the owner of a plant or other property or equipment, it may be the cost per unit of output produced by the facility. For the contractor, a rough measure often is the percentage by which costs are below (or above) the payment received from the owner.

Fisher (1990)	Productivity = total income / (cost + goal profit)
Aspén et al. (1991)	Productivity = value added / input of production factors
Hill (1993)	Production is defined as the ratio of what is produced to what is required to produce it. Productivity measures the relationship between outputs such as goods and services produced, and inputs that include labor, capital, material and other resources.
Thurow (1993)	Productivity (output per hour work) is the central long-run factor determining any population's average of living.
Koss and Lewis (1993)	Productivity = the quality or state of bringing forth, of generating, of causing to exist, of yielding large results or to yielding abundantly.
Bernolak (1997)	Productivity means how much and how well we produce compared to the resources used. If we produce more or better goods from the same resources, we increase productivity. Or if we produce the same goods from lesser resources, we also increase productivity. By "resources", we mean all human and physical resources, i.e. the people who produce the services, and the assets with which the people can produce the goods or provide the services.
Stainer (1997)	Productivity ... can be seen as the combination of effectiveness and efficiency and described as the value of performance achieved in relation to the cost of resources used.
Kaplan and Cooper (1998)	Productivity is a comparison of the physical inputs to a factory with the physical outputs from the factory.
Jackson and Petersson (1999)	Productivity = efficiency * effectiveness = value adding time / total time
Al-Darrab (2000)	Productivity = (output / input) * quality = efficiency * utilisation * quality
Moseng and Rolstadås (2001)	Productivity is the ability to satisfy the market's need for goods and services with a minimum of total resource consumption.
Johnson and Jones (2004)	Productivity is the ratio of what is produced by an operation of processes to what is required to produce it, or put simply the ratio of actual output to input over a period of time.
Atallah (2006)	Productivity is the extent to which the operation achieves optimal quality and cost and time efficiency. The more productive the operation is, the higher the profit margin per unit. In construction, productivity is usually associated with the amount of work a worker completes during a period of time.
Crawford and Vogl (2006)	Productivity describes the output potential of a production process conditional upon its inputs.

The terms that are recognised as most important in the definitions presented in the table above are cost, resources and value. These will be further described.

3.2 Related terms

The focus in this section is to clarify terms that are often used in connection with productivity. They are used to establish a basis for how to interpret productivity. The terms that will be described further are: 'resources', 'cost of the use of resources' and 'value added' (Figure 3.3, further developed from Figure 3.1 with inspiration from Tangen, 2004). The above terms are commonly mentioned in the productivity

literature (cf. Prokopenko, 1987, Sink and Tuttle, 1989, Ghobadian and Husband, 1990, Koskela, 2000) (see Table 3.1).

Throughout this thesis performance and profitability are, as suggested in the triple P-model presented by Tangen (2005) (see Appended paper I, Figure 5), viewed as the outer frames for productivity (see Figure 3.3). From Tangens (2005) model performance is described to measure in quality, delivery, speed and flexibility. Profitability is in the same model described to measure price recovery. From this point of view productivity is central to measuring and improving both profitability and performance. But productivity is by this view not affected by performance or profitability (Tangen, 2004). Since profitability and performance does not affect productivity they are not further described. Figure 3.3 will serve as the model for understanding productivity in this thesis.

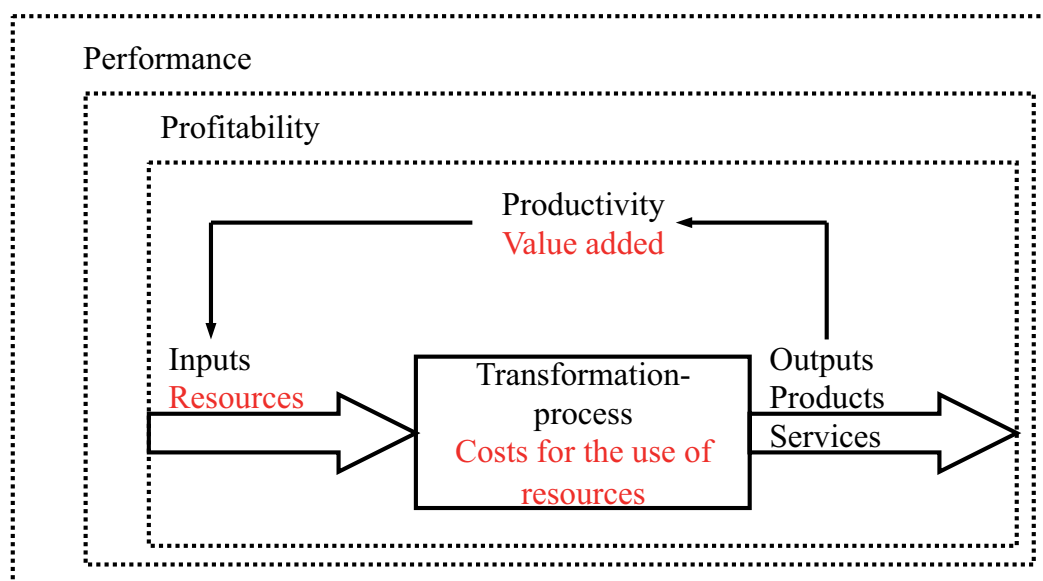


Figure 3.3. *Resources, costs for the use of resources and value added in relation to productivity, profitability and performance.*

In this model of productivity resources are identified as the inputs that are needed in order to conduct any activity in the transformation process (Koskela, 2000). Also the outputs (products and services) are viewed as resources. Costs are viewed as a monetary measure directly related to the sacrifice of resources at some point in time (Prokopenko, 1987). This sacrifice occurs in the transformation process when input resources are consumed and transformed to output resources that can be sold for a price. Costs for the use of resources are not only connected to financial resources, but also to time resources that are needed to identify ownership. Both resources and costs for the use of resources are viewed as factors in the transformation process that are necessary to create value for customers (cf. Saukkoriipi, 2005). The concepts of value and non-value, which are connected to the unnecessary use of resources, will also be described.

3.2.1 Resources

The importance of linking resources to productivity has been articulated by e.g. Grubbström (1995), who from a historical perspective states “*production is the process of transforming one set of resources (inputs) into a second set (output)*” (p. 1).

Thereby, the transformation process is viewed as what changes inputs with given values to outputs with other values (Figure 3.1).

Which resources are viewed as inputs to the transformation process depends on how productivity is managed by the firm (labour, capital, material or energy; see Figure 3.2) and at what level within the firm the question is raised (Sink and Tuttle, 1989). A useful definition of a firm's resources is given by Wernerfelt (1984, p.172). He defined resources as “*anything which could be thought of as a strength or weakness of a given firm*”. Porter (1981) identifies resources as the strengths that firms can use to conceive and implement their strategies. These definitions are also in line with Gadde and Håkansson (2001) who argue that resources are a heterogeneous category. They further suggest that the value of resources changes depending on how they are combined with other resources. Both the resource-base of the organisation (its internal resources) and its external resources (resources controlled by other organisations) are commonly drawn on when identifying resources (Prokopenko, 1987, Winch, 2006).

Resources are usually divided into tangible and intangible resources (Caves, 1980). Production facilities and equipment are typical examples of tangible resources (Gadde and Håkansson, 2001). Intangible resources may be exemplified by know-how, brands, relationships and the external image of the organisation (Wernerfelt, 1984, Gadde and Håkansson, 2001). Both tangible and intangible resources are assets for the organisations that control them. The monetary value of intangible resources may however be difficult to estimate.

An organisation thus has to consider several aspects of resources (Prokopenko, 1987, Womack and Jones, 2003). A simplified version consists of two aspects: objects (tangible resources) and people (intangible resources). When interrelating these two resources the activities needed in the transformation process are identified. To these resources, time and money can be added. The first aspect, monetary resources - include money and thereby price and cost of goods and work (Figure 3.4). The second aspect regards time as a resource. By adding time, ownership of goods and availability of human resources at specific times are become involved (Figure 3.5) (cf. Mellerowicz, 1963). In paper II financial resources and time resources are further developed into the three aspects of time resources, cost resources and knowledge resources.

Financial resources: To identify costs and assign them to a specific time-period, tangible and intangible resources are complemented by money measures (financial resources Figure 3.4). The cost of tangible resources is thus estimated by the price that is paid for a product. Likewise, the costs for intangible resources may be estimated by considering wages paid to keep employees as members of the organisation (Drury, 2008).

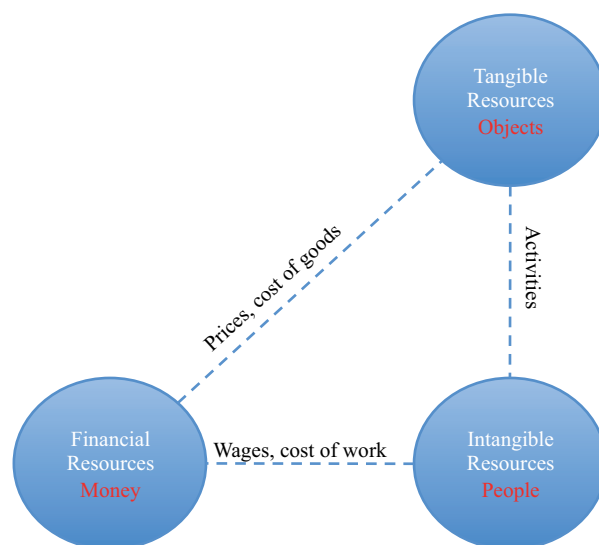


Figure 3.4. Resources and money.

Time as a resource: It is also of value to locate the physical aspects of resources in time. The dimension of time affects organisations in different ways (Holmlund, 1997). The time aspect is reflected in delivery agreements with subcontractors, but also in the delivery periods. Late delivery may lead to added costs for the client as well as for subcontractors. By considering the time resource, further aspects of managing time constrained projects may be structured.

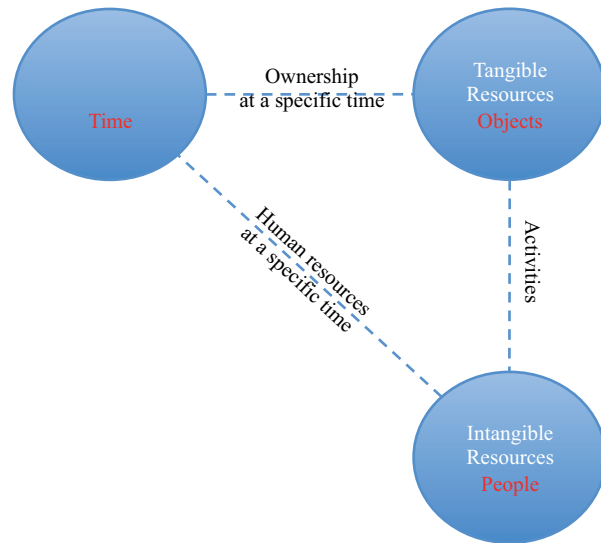


Figure 3.5. *Resources and time.*

To improve the use of resources from both the above views, close cooperation and effective communication between actors is required. This could be particularly important in construction organisations (cf. Dainty et al., 2005), which are heavily dependent on people’s effort (Chan and Kaka, 2007).

3.2.2 Cost for the use of resources

Koskela (2000) claims that reducing cost is a key principle for “*making the transformation process more productive*” (p.43) hence he closely relates productivity and cost (see Figure 3.3). He further claims that increased productivity can be obtained “*...by reducing the cost of production for the same output*” (ibid, p. 43). Jonsson (2005) explains that the slow growth of labour productivity may be a reason for why costs in the Swedish construction industry have increased more than in other industries.

Costs are not to be confused with capital. This is underlined by Drucker (1991) who contends that capital cannot be substituted for labour. In traditional calculations, costs for the use of resources are seen as the monetary measure that reflects the sacrifice of material assets, ‘goods’, and the use of non-material assets, ‘services’ (Schoch and Yap, 1998). It is however important to interpret the cost concept correctly. To do so the origin of the statement must be examined. In the German context that is used in Sweden, cost is a measure of the monetary value that is associated with the use of specific resources during a given period of time (Olsson and Skärvad, 2002). The Anglo-Saxon concept of cost is not quite as clearly related to the time aspect. Instead, preceding adjectives are used to explain the cost in question (Drury, 2008). Throughout this thesis the German usage of costs are used.

Price and Cost: It is important to distinguish between price and cost. Price is understood as an agreed monetary value of a product or service between a supplier and a buyer. Cost on the other hand, is a monetary measure associated with the resources that have actually been used (Mellerowicz, 1963). As a rule, the cost of a product is associated with activities and thus regarded as an input factor in the transformation process (Figure 3.3). When the contractor pays a price for a product or

service to a supplier, the latter receives revenue. This revenue should cover the costs of the supplier and may also provide some profit. According to the German and also Swedish cost focused literature a purchased asset is therefore not immediately recognised as a cost (Mellerowicz, 1963). The cost does not appear until the asset is used up or sold.

3.2.3 Value added

In general value is used to express the worth of an object as such, or the evaluation of an activity in terms of its outputs (Hutton and Devonald, 1973). Value may however be viewed differently in different parts of the organisation. At top managerial level, the general focus of value is on profit for the organisation. On an individual level the focus of value may be to receive a good salary and to stay healthy. It is thus a complex term, quite difficult to clearly define. What follows is a description of how value is understood and used in this thesis.

The value of a product becomes visible when there is a demand for that product. Womack and Jones (2003 p. 353) define value as: *A capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer.* They state that the customer should perceive the value of an output and then pay for it, which gives revenue to the contractor. In a financial context, the sum of the costs of the resources used in the transformation process may be estimated. This is a basis for comparison with regard to the value that has been added in the transformation process (Koskela, 2000). From this aspect it is possible to relate the cost for the use of resources to value. Koskela (2000, p. 44) further explains the principle of value as: *“The value of the output of a process is associated with the value ... of the inputs to that process”*. He asserts that value relate input to output. Liker (2004), in line with Womack and Jones (2003), describes increased value in a product as giving the customer what she/he wants and what she/he pays for.

Unnecessary use of resources: This refers to both non-value adding activities and material waste. According to Forsberg (2008), non value-adding activities are related circumstances, activities and processes that do not add value to the final product. Womack and Jones (2003 p.350) consider a non-value adding activity to be *“any activity that consumes resources but creates no value”*. Formoso et al. (2002 p. 317) instead use the term waste which they define as *“the loss of any kind of resources – materials, time (labour and equipment), and capital – produced by activities that generate direct or indirect costs but do not add any value to the final product for the client”*. In accordance with these resource statements resources are in this thesis viewed to be unnecessary if they do not add any value to the customer.

An on-going challenge in the construction industry is to increase productivity by repeatedly reducing the unnecessary use of resources (cf. Maani, 1989).

Hines and Rich (1997) link the use of resources to activities and categorise these into three groups;

- Non-value adding activities comprise actions that are not relevant for the transformation process of which they are a part of. They can therefore be removed without consequences to the final product. These activities should be removed carefully. For example, attempting to decrease unnecessary

movement caused by a large setup of a production facility can backfire because the workers might perceive the space as an agreeable working climate. Productivity might also decrease if the setup is changed.

- Necessary, but non-value adding activities are activities that do not add value in the course of the process. Examples are safety regulations that affect the process or unnecessary movement caused by poor layout of the facilities. Changing the setup of the work processes can reduce this kind of resource consumption.
- Value-adding activities add value to the product. Examples of an activity that are directly value-adding activities is laying bricks, painting the outer layer on a wall or bolting on the tires of a car.

In practice, the distinction between non-value adding activities and necessary-but-non-value adding activities is not always obvious. Thus activities should be studied and identified with caution. If the three categories presented above are identified, and the non-value-adding activities are to some extent eliminated, the costs related to the product can be decreased and the value for the purchaser increased, either by lowering the price or raising the service level and/or quality of the product or service.

According to Womack and Jones (2003) it is important to realise that it is not necessarily the leaders in an organisation who find and reduce the non-value adding activities. According to Liker (2004), to not giving due attention to the employees' ideas may be viewed as a waste of resources. He calls this "*unused employees' creativity*" (ibid p. 29) and states that it leads to loss of time, ideas, skills, improvement and learning opportunities.

In this part of the theoretical framework the development of the term productivity and related concepts resources, cost for the use of resources, and value added have been described. In the following part productivity in a construction context will be in focus.

3.3 Productivity in construction projects

In a report on productivity in Swedish construction Jonsson (2005) found that both researchers and practitioners must work towards improving production processes in order to be able to compete on a global market. In the report, he made the case that productivity and productivity improvement are key issues in this process, especially in industrialised countries like Sweden, as these countries cannot compete with lower wages and less costly raw materials. Jonsson (2005) further argues that if productivity is not considerably improved, the ability to compete with other, less industrialised nations, may be lost. This report has been well received in the Swedish construction industry. Today the term is often used. To grasp the extensive use of the term productivity in construction, annual reports from a major construction contractor were analysed. During a three-year period the term was used 19 times (7 times in 2007 and 2008, and 5 times in 2009). An example from an annual report for 2008 says; "*Increased productivity leads to increased profitability. One way to increase productivity is to increase standardization in design, method and the choice of material and thus reduce production costs*" (translated from Swedish). Considering the various meanings of the term, it is understood differently by readers, even if they belong to the same organisation.

There have been numerous attempts at identifying and classifying factors that impact productivity in construction (cf. Bröchner, 2011, Lind, 2011). Dai et al., (2007) argue that few attempts have been made to identify their relative importance. This is surprising, since reducing the unnecessary use of resources and increasing productivity, often in combination, have long been claimed to be a priority for the construction industry (Murray and Langford, 2003, Park et al., 2005, Harrison, 2007, Abdel-Wahab et al., 2008, Haas, 2008). Among the most common suggestions of how to increase productivity from a construction perspective are:

- Increase communication (Tucker, 1986).
- Find and implement better techniques (Drucker, 1991).
- More efficient employees (doing things the right way) (Abdel-Wahab et al., 2008).
- More effective employees (doing the right things) (Fearne and Fowler, 2006).
- Lower quality (Johnston and Jones, 2004).
- Less use of resources or reduction of non-value-adding activities (Egan, 1998).
- Increased standardisation (Santos et al., 2002).

Basically these suggestions envisage more outputs by using less inputs (Tangen, 2005 see also Figure 3.3), but do so from different aspects. Both material and non-material resources are in focus in the different perspectives. Since productivity is generally understood as producing more for less (Tangen, 2004), pressure is constantly exerted on the organisation to increase output or reduce resources used as inputs. As Green and May (2005) argue, if not enough resources are utilised in the inputs the firms risk becoming ascetic with little room for employees to develop and voice their opinions. The two questions what does improving productivity in construction cause, and how does it affect employee motivation, are interesting issues to research.

3.3.1 Productivity in construction depends on the efforts people make

For a company to show a profit, a satisfactory work environment for its employees is needed, as well as a culture that encourages employees to make continuous efforts to improve the productivity of their organisation (Bruzelius and Skärvad, 2004). If the individuals in a construction project are not engaged in the process of improving productivity, they will have no motivation to make any efforts to improve productivity (Mustapha and Naoum, 1998). Therefore, the goal to increase productivity may lead to a loss of motivation under adverse circumstances. Key employees (e.g. production managers) with skills that can get them new jobs in other firms may start looking for work elsewhere when their motivation decreases (*ibid*).

To maintain employee motivation it has been suggested that improving productivity should not be seen as working harder, but working more intelligently (Tucker, 1986). He concludes that in order to improve productivity, attention should be focused on managerial issues that promote communication. Thus working less for more outputs. Another means on improving productivity while maintaining motivation has been presented by Abdel-Wahab et al. (2008) who studied skills and productivity in a UK

construction context. They found that the general consensus in construction was that skills development and training were prominent factors for improving productivity. This is also in line with the reasoning of Drucker (1991) who stated “*whether tools help productivity or harm it depends on what the people do with them, on the purpose to which they are being put, for instance, or on the skills of the user*” (p. 71).

However, communication might not be a sufficient tool on its own. Different key actors such as controllers, engineers and technicians all have different professional views on productivity (Sink and Tuttle, 1989, Ghobadian and Husband, 1990). They also have to be able to understand each other for the communication to be effective (the reader is reminded of the annual reports described in the beginning of this chapter where productivity was used 19 times). The different individual interpretations of productivity provide a variety of suggestions on what to include in the concept (Tangen, 2005). Since there is little consensus over the meaning of productivity, improving it is difficult (Lundberg, 1961, Johnston and Jones, 2004).

In the following final part ways of improving productivity by reducing the use of resources will be presented from a construction project perspective.

3.4 Improving productivity

Authors focus on different aspects of productivity improvement (McTavish et al., 1996). No generally accepted formula of how to improve productivity has been identified (Park et al., 2005). The efforts people in construction make have been recognised as especially important when considering productivity improvement since the industry is claimed to be labour intensive (Forsberg, 2008) and people oriented (Chan and Kaka, 2007).

Labour productivity in itself includes many factors, both quantifiable and indeterminate. Forsberg (2008), who wrote his thesis on productivity measures on Swedish construction sites, found that production managers often use square meters produced per hour or cubic meters produced per hour when measuring productivity. Other variables such as consumed time for an activity compared to planned time, and the customer’s level of satisfaction were also found to be used. In the same study, when the question regarding productivity was directed to top management at three Swedish construction contractors the focus was profitability, economy and cost per hour. At a higher level in the organisation, the measures are in monetary units or terms that are related to profitability (Forsberg, 2008). His study shows that there is a disconnection between site and top management. At site management level, productivity was measured with main focus on time. At higher organisational levels productivity was determined using financial measures. When considering the model of productivity (Figure 3.3) the difference in prioritising resources (the input factor) affects the view on productivity. It could be suggested that top management prioritises profitability over productivity.

Since the input factor in the model (Figure 3.3) varies with the interpretation of productivity, it will affect the view on what can be sacrificed to gain control over certain resources. The cost for the use of resources and the value added is not fixed as they depend on from what perspective the activities in the transformation process is viewed. To increase productivity in construction it is therefore of value to establish an

understanding how the view on the use of resources varies when taking either a time resource perspective or a financial resource perspective.

In this thesis, two suggestions to improve construction project productivity are examined. The first are suggestions production managers have concerning the firms' productivity improvements through reducing the use of resources as suggested by Liker (2004) and Josephson and Björkman (2011). The second was to examine if increased standardisation, as a means of reducing resources, could be a way to increase productivity as suggested by Santos, et al. (2002).

3.4.1 Reducing the use of resources

As already stated, a useful definition of resources is given by Wernerfelt (1984, p.172) who regarded resources as "*anything which could be thought of as a strength or weakness of a given firm*". This view is also maintained in appended paper II. Gadde and Håkansson (2001) argue that resources are to be viewed as a heterogeneous category and that their value can change depending on how they are combined with other resources.

In line with Wernerfelt's (1984) definition, information and knowledge should be viewed as resources. Craig and Sommerville (2006, p.145), argue that "*historically, the nature and scope of the industry often meant that many processes were replicated, resulting in waste and inefficiencies amongst project partners*". They underline their argument by suggesting that the increased complexity of construction projects requires that all information about a project be shared among all the actors working on it. Even though their suggestion is myopic and would probably consume considerable resources it underpins some authors' views of the importance of communication and knowledge.

Following a similar, but less extreme argument, Winch (2006) maintains that the increased complexity of organisations requires a better flow of communication between all actors working in the projects and also with suppliers to ensure an even and timely flow of materials. Dainty and Brooke (2004, p.28) argue for the need for information and communication to reduce waste in projects by stating that "*every waste strategy requires adequate management resources to oversee and enforce its implementation, which in turn requires that contractors see the reduction of waste as a core priority with tangible benefits for their business*". This is often viewed to be a task for top management.

Moreover, Flanagan et al. (2007) suggest that the overall improvement of the construction industry cannot be achieved without integrated efforts by all parties involved in the projects and processes. They concluded that the industry, the firms and their project teams need to be involved in the communication process in order to achieve better results. However, Dainty and Brooke (2004) questioned if the industry is culturally ready for the collaborative relationships that are necessary to bring about radical improvements in reducing unnecessary resource consumption.

The statements above throw light on the importance of using resources intelligently in order to reduce them. By increasing communication, the use of unnecessary resources may be reduced. But communication in itself may be viewed as unnecessary (cf. Craig and Sommerville, 2006). Still it is important for top management to bear in

mind the importance of reducing the use of resources and to recognise the benefits it may bring so that middle management is not “*stuck in the middle*” (Styhre and Josephson, 2006 p. 521).

Hines and Rich (1997) have contended that reducing the unnecessary use of resources is important in order to develop a competitive advantage for the firms. They claim that the reduction of resources focus should be on increasing productivity, but not necessarily on increasing quality. To gain practical insight into the problem of consumption of resources, Josephson and Björkman (2011) discussed the most common causes of unnecessary use of resources (categorised in Table 1, appended paper II p.7) with experienced practitioners from the Swedish construction industry.

3.4.2 Increasing standardisation in construction projects

The second aspect of improving productivity is the question of how increased standardisation is seen to affect productivity in construction projects from a production management perspective.

Standardisation is a way to increase productivity through finding more homogeneous practices (Jonsson, 1996, Egan, 1998, Santos, et al., 2002). It has been argued that by introducing standards into construction projects, the root causes to production problems can be identified and routines may be established that lead to more consistent operations (Ungan, 2006). Furthermore, by implementing standards, individual processes could become easier to control for production managers. Mustapha and Naoum (1998) instead argue that valuable motivators for production managers to seek high quality of work are responsibility and autonomy. They maintain that these are major determinants of an organisations’ ability to recruit, motivate and retain skilled workers. They claim that standardising the managers’ work role may conflict with their need for freedom to make own decisions in their daily work. The conflict between increased standardisation and an individual’s sense of freedom can also be found in Green’s (1999) article where he critically questions the lean construction philosophy. By increasing standardisation, the motivators for quality of work may be affected. Both tangible and intangible resources can be lost due to decreased worker motivation.

From a critical point of view, increasing the degree of standardisation could lead to a loss of productivity as competent site managers might lose their motivation and ultimately leave the firm. If the production manager, as has been claimed by (Styhre and Josephson, 2006 p. 523) really is responsible “*not only for technical and production related matters on the construction site, but also has to be trained in administrative work, legal matters, human resource management and some other activities generally functionally organised into different departments and work roles*” then they are to be viewed as key resources for their firms. If they leave their firms because of loss of motivation, the firms lose these valuable resources and could thus lose their ability to be productive or to increase productivity. Consequently, increased standardisation might lead to a loss of competence and knowledge in the firm.

Prendergast (2004) argues that in order to tackle problems faced when dealing with freedom, individual freedom has to be recognised as a social commitment to adapt to the rest of society and to other individuals’ needs. Ljungqvist (1987), who discusses freedom from a psychological perspective, asserts that freedom is somewhere on a

scale between total dependence and total isolation from other people. Sandoff and Widell (2009) argue that individuals who feel free in their work role are more likely to challenge established routines and to bring about changes that make work more effective. They also suggest that if there is passion for work, if pleasure is sought after instead of pain and the individuals are allowed to take on responsibilities, the individuals will feel freedom in their role. From a construction perspective Styhre and Josephson (2006) suggest that site managers take pleasure in the freedom and the responsibility that is given to them. So, perhaps what production managers really want in order to increase productivity is greater freedom rather than more standardised routines and processes to follow.

3.5 Summary

By looking at productivity from different perspectives the term has been found to rest on the base provided by a transformation process with inputs and outputs. The term is defined as the relationship of input resources to output resources in the transformation process in accordance with the model presented in Figure 3.3. Central terms are: resources, cost for the use of resources and value added. These terms builds up the model of productivity that is used. Resources are connected to the input and output factor. Cost for the use of resources is connected to the transformation process where resources are consumed and transformed into other resources that become the outputs. In the transformation between inputs and outputs value is added.

Even though an overall view of productivity is presented, the term raises more questions than it answers. The difficulties of finding a single definition are shown. A significant difference that has surfaced in the literature that concerns productivity is the various perspectives that have been presented, how differently actors interpret it and how to improve it. It is recognised that one reason for this may be that the difference between the terms performance, profitability and productivity have not yet been well identified or well defined.

Various approaches to productivity may be relevant since different industries and levels in the firms as well as individuals focus on different things. Therefore it is even debatable if one definition of productivity is worth looking for. Different industries and different levels within the firms might need to focus on productivity in different ways.

The narrowed down focus in the frame of reference therefore addresses the issue of implementing improved productivity on projects in construction. This is also recognised as being difficult due to the uniqueness of construction projects, which in the literature is illustrated through both project diversification and professional fragmentation. Different individuals in construction projects are also recognised to have different views on productivity, resources, cost for the use of resources and thereby value added. From this context the importance of the production manager role has been identified. Production managers are in the literature described as key players for project success. Their views on productivity improvements have been identified as being important.

4. Research methods

Hard choices have to be made when planning research (Holme and Solvang, 1997, Svenning, 1999). Various alternatives must be considered and choosing the right one is difficult. For example Arbnor and Bjerke (2009) say that no one best solution can be found when choosing methods. They suggest that methods to tackle problems will differ depending on which assumptions that are made and on which grounds these assumptions rest.

This chapter describes the paths chosen for gathering and analysing data for this thesis. The methods used will be motivated and discussed. But before the paths chosen in this study are further described some overall methodological considerations will be presented.

4.1 Methodological considerations

The basic standpoint in the methodological consideration in this thesis will be the separation of research strategies as presented by Bryman (2008). His view is visualised in Table 4.1. Even though the Table simplifies the connections between different scientific views it provides a conceptualisation of the terms, which will suffice for the methodological reasoning in this thesis. The reasoning by Patel and Davidson (1994) on how to interpret terms may be of use in creating a basis for understanding the framework that is used in this thesis.

Table 4.1. *Fundamental difference between quantitative and qualitative research strategies (Bryman, 2008, p. 22).*

	Quantitative approach	Qualitative approach
Principal orientation to the role of theory in relation to research	Deductive approach, testing theory	Inductive approach, generating theory
Epistemological orientation	Natural science model, in particular positivism	Social science model, in particular interpretivism
Ontological orientation	Objectivism	Constructionism

In line with Bryman (2008) and Patel and Davidson (1994) purely qualitative or quantitative oriented research are viewed as extremes of a continuum.

4.1.1 Methods chosen in this thesis

No absolute truths were sought in this study. Instead the aim has been to reach a deeper understanding of productivity and improving productivity in construction from contractor's perspective (see Figure 4.1, Problem formulation part 1). The aim and the first research question have remained unaltered throughout the study. The two later research questions have been allowed to develop along the way (see Figure 4.1, Problem formulation part 2). Since much of the literature that was reviewed concerned top management and their views on how to improve productivity in construction production managers were chosen to be in focus in the study. As the term productivity was further examined, ways of improving it were identified and research

questions two and three were formulated based on this. After the two later research questions had been formulated the interview study was begun.

The study for this thesis has to a great extent been influenced by secondary sources, the setting of the study and most significantly the fifteen interviewees (see Figure 4.1, II and III). Interpreting the interviewees' views has thus been a major part of the input to the discussion and conclusions presented in this thesis (see Figure 4.1, IV). In the process of analysing this data my opinions and ways of interpreting what has been said have developed. The development has resulted in a quite subjective approach.

The path chosen for the part II and III in the study may be viewed as interpretative and inductive. This approach has left room for interpretation and discussion in line with Bryman (2008).

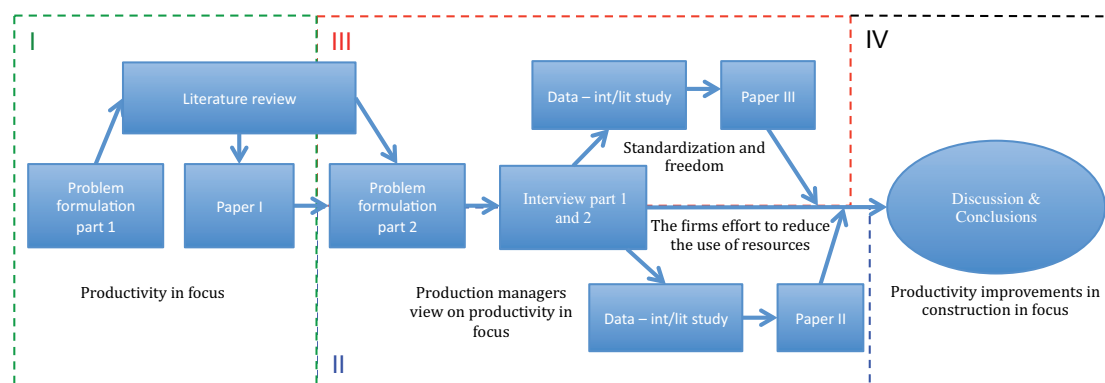


Figure 4.1. The process of writing this thesis.

To generate knowledge in a practical field both inductive and deductive approaches are often suggested (Patel and Davidson, 1994, Dubois and Gadde, 2002, Bresnen, 2007, Bryman, 2008). A combination of approaches has been seen as valuable by researchers with similar questions. For example by Dubois and Gadde (2002, p 555) maintain that: “... *theory can not be understood without empirical observations and vice versa*” and they also argue that theoretical conclusions may be enriched by observations in practice (abductive approach).

Since different approaches have been used in different parts of the study the discussion and conclusions in the thesis could be seen to draw on methodological pluralism (Dainty, 2008) - a combination of different approaches. The different approaches can be divided into periods (see Figure 4.1, I, II, III and IV) in which different methods have been used. The initial part of the study can thus be described as descriptive and objective; the construction industry and the term productivity were explored by analysing literature. The latter parts of the study can be considered interpretative as the managers' reflections over productivity improvements were explored through fifteen interviews with production managers in three contractor organisations in the Gothenburg region. The two later parts are to be viewed as inductive since the theoretical framework, the aim and the research questions have been developed throughout the process.

4.2 Data collection

To adapt to the demanding day-to-day work of production managers in construction, it was decided to meet each of the fifteen respondents on one occasion and at

locations of their choosing, mostly at their construction sites. Empirical data was collected for both RQ2 and RQ3 on this occasion. When meeting the managers, the empirical data collection was divided into two clearly separated parts, beginning with an open discussion on RQ3, after a break that included coffee a structured interview form was given to the interviewee to respond to RQ2.

Three researchers were present at the first two interviews. In the following interviews two researchers were present at nine and one researcher present at four. I participated in 12 of the 15 interviews that are considered in this thesis. Five more similar interviews were conducted with a tool rental company. This company was part of the research study that this thesis draws on, and these five interviews have therefore also been considered and analysed, but are not used in this thesis since they do not concern a contractor organisation. All interviews were recorded and notes were taken. All interviews were conducted in Swedish.

4.2.1 Interviews part I

Gathering data for research question 3 - the relationship between the production managers need for freedom in their projects and the firms' need for standardising to improve productivity - was done with explorative semi-structured interviews with an open-ended approach (Chen and Partington, 2006, Åkerlind, 2005). In this part of the fifteen interviews open-ended questions were asked. These were primarily based on principal and follow-up questions (Kvale, 2007) to encourage the interviewees to continue their line of argument beyond the boundaries of this specific work in accordance with Silverman (2000).

This part of the interviews varied from 70 to 100 minutes. The open-ended approach was undertaken to avoid influencing the interviewees (Holme and Solvang, 1997, Åkerlind, 2005). Focus was on the respondents' perspectives and understandings of issues related to improving productivity. According to Åkerlind (2005, p. 322) this is of value since the goal is to gather categories of descriptions to differentiate between the "*empirically interpreted views*" from the "*hypothetical experiences*" among the interviewees.

4.2.2 Interviews part II

The empirical data for the second research question "*what views do production managers have concerning the firms' productivity improvements through reducing consumption of unnecessary resources?*" was organised into a structured interview form Bryman (2008). The interviewees were asked to reflect over how much their organisation dealt with 31 recommendations for profitability improvements by positioning their estimation on a line graded from *very much* to *very little*.

The researcher's interaction with the subjects was limited to clarifying the recommendations and to answering questions from the interviewees. After the interviewees had put a mark on the scale, they were also asked to reflect over how well they thought their company worked with the recommendation in question in comparison to other construction companies. This part of the interviews varied from 25 to 45 minutes.

4.3 Analysis of data

In order to increase the reliability of the empirical data collection, it was decided to adopt a qualitative approach in the first part of the interview and a quantitative

approach in the second part (see Table 4.1). Having been inspired by other studies with similar questions (e.g. Faniran and Caban, 1998) paper II took a quantitative approach, where reflections over the managers opinions of their firm's attempts to reduce the use of resources were analysed. The approach taken in Paper III was inspired by Åkerlind (2005) who presents an open-ended view. The study accordingly took on a more qualitative approach based on discussions and open-ended questions. The answers to these questions needed to be interpreted.

After the interviews, two researchers discussed the observations and reflections that had been gathered. In these reflection sessions the impression if the interviewees expressed a need for increased freedom or increased standardisation were discussed. I transcribed the first part of the interviews verbatim and also relevant sections of the second part.

The quotes from the interviewees throughout the text have been translated into English. At times the translation can be understood as different from the Swedish context. As an example of this limitation, the distinction between efficiency and effectiveness does not exist in the Swedish language. When the Swedish term "*effektivitet*" has been used the author has interpreted the term out of the context of the sentence.

5. Summary of the papers

In this chapter the content of each paper is summed up and its contribution to the thesis is presented. The methods used when designing the studies that the articles are based on have been described in the previous chapter. Purpose, findings and reflections will be presented in the following chapter.

5.1 Exploring the complexity of productivity in construction: Paper I

Purpose

The purpose of paper I was to explore the concept productivity and its application in the construction industry. An attempt was made to disentangle a number of related concepts through reviewing the literature that describes productivity from various angles. Special attention was paid to the historical background of the term. The aim was to acquire an understanding of how the usage of the term has changed through time and how different perspectives have been taken up. Particular attention was given to the terms efficiency, effectiveness and performance as these often are used interchangeably with the term productivity.

Findings

The findings point towards a need to incorporate several aspects of productivity to determine how to use the concept before it is applied in organisations. The reason for this is that there are various opinions as to what the term means. Different historic, individual, professional and scientific reasons for this are identified in the article. In day-to-day practice, productivity is suggested to integrate the dimensions of efficiency and effectiveness. The former concerns the ratio between measures of input and output; the latter gives a pre-assigned value to relate to. It is also argued that without the effectiveness aspect i.e. being able to compare productivity-measures, a meaningful use of the term is difficult to establish.

It is argued that the construction sector consists of practitioners, engineers and controllers. Since the industry consists of individuals who have different professions, it is recognised that it is of importance that all actors interpret productivity in a similar way. Therefore, from a construction aspect, it is suggested in the article that productivity should be related to the components of the triangle; time, cost and quality. Based on the literature, these aspects reduce the feeling of complexity that is attached to the term. The concluding suggestions focus on the applicability of the term itself and that the actors are in agree over the meaning of the term before it can be applied in practice.

Reflection

The main reflections from the article are the diversity of interpretations of productivity that exist among the actors in the industry. This diversity is well illustrated when construction projects are looked at, with many subcontractor organisations and many hierarchies within a project. The contexts in which productivity is used are quite different, depending on activities, the individuals' professions and hierarchical level within the construction project. Views on how to measure productivity seem to be context-dependent and thereby depending on what is produced.

In hindsight, it is clear that the article only explores the surface of the productivity concept and can be considered as an initial attempt to understand it. The reasoning in the article revolves around the triple-P-model presented by Tangen (2005) without taking into consideration which terms that really make up its basis. After the publication of the article it was realised that resources, costs for the use of resources and value added also have to be defined to identify a basis of productivity.

5.2 Reducing the use of resources in construction: Paper II

Purpose

The purpose of paper II was to contribute to the debate about what construction firms do - and do not do - to reduce the use of resources. The paper was written to examine how production managers, working on-site, perceive their firm's efforts to reduce the use of resources, thus attempting supplement the productivity debate from a resource input-output perspective. Thirty-one recommendations to avoid unnecessary consumption of resources, developed by Josephson and Björkman (2011) in collaboration with the industry, gave a basis for the questionnaire used in the study. The findings are drawn from structured interviews with fifteen production managers in three medium-sized contractor organisations (see section 4.2.2).

Findings

Six of the thirty-one recommendations elicited particular interest from the interviewees. The three recommendations that received the highest scores were: Define the factual customer requirements; Encourage further training; and Seek long-term customer-supplier relationships. These were contrasted to the three recommendations that received the lowest scores: Actively support suppliers in their development; Measure in order to uncover waste and; use all of the week's 168 hours. From these six recommendations three correlated findings were highlighted.

The first finding is that that the interviewees perceived the importance of reducing costs as the most important means of creating competitive advantage based on knowledge and time. The second finding is that managers see increased collaboration with suppliers through supporting them in their development as an unnecessary expense, and, in some cases, as a risk. This is in stark contrast to much of the literature that argues that all organisations in the supply chain should be involved in improving performance (see for example, Love and Li (2000) and Dubois and Fredriksson (2008)). The final finding reveals the perceived low interest from top management in gathering information about consumption of unnecessary resources or to refining such information into knowledge and how it affects production managers' attitudes to avoiding unnecessary resource use in general.

Reflection

The main reflection from the article was the all-encompassing cost aspect that was shown by the managers. When asked to reflect on how their organisations were perceived to work with the recommendations, the interviewees repeatedly associated them with material resources that were easily connected to cost aspects that had non-material focus. It was identified that the short-term focus, encouraged by top management, made the interviewees take on a cost approach to project performance (cf. Green and May, 2005). The superiors did not encourage the interviewees' to increase productivity by reducing the use of resources.

5.3 Freedom and Standardisation in construction: a managerial perspective: Paper III

Purpose

The purpose of paper III was to explore how standardisation may conflict with the production managers' sense of freedom. Its point of departure was the production managers' situation at work, contrasting organisational control through standardisation on one hand with the production managers' need for freedom on the other. The purpose of the article adds to the conception of productivity by questioning how increased standardisation in projects may be perceived by middle managers from a transformation process perspective. The article draws on a literature review and explorative interviews with 15 production managers in three medium-sized Swedish construction firms (see section 4.2.1).

Findings

The findings show that the managers' view on standardisation and freedom was not necessarily to avoid standardised solutions or to maintain high levels of freedom. The interviewees' clearly related freedom to their capability to influence and overview their production processes. It was frequently indicated that the implementation of standards that decreased uncertainty and variability was not perceived to reduce their freedom, as long as they could be absorbed into the project organisation and were accepted by the sub-contractors of the project. It was also maintained that standardisation of materials, specific activities, regulations or safety measures could in fact lead to freeing more time for the managers to do more important work. The managers instead saw as important their possibility to follow the projects' financial development, influence the project team, update its schedule or inform the client on the project process.

The managers wanted to be entrusted with freedom to make autonomous decision and to be to some extent shielded from the interference of others. They still wanted to act within given frames set by top management. Instead of avoiding standardisation, their main concern was to be able to influence which standards would be implemented. It was argued that such standards had to be based on previous experience, not necessarily their own experiences, but those that had proven effective.

Reflection

The study shows that production managers in medium-sized construction companies are not averse to standardisation. As long as standards are respectfully implemented, based on experience and do not affect the managers' ability to influence the production process. Standards may even be perceived to generate freedom for production managers. Consequently, in order to deal with the challenges that are raised by the need for standardisation and the production managers' needs for freedom, further standardisation of project activities may be developed slowly and with respect using a bottom-up approach.

6. Discussion

It is somewhat surprising that the recommendations in many construction reports seems to strive towards finding one solution to improve productivity (cf. Murray and Langford, 2003, Bröchner, 2011). The difficulty of finding one definite solution to solving the problem of low productivity in construction is clear. There are many different views about what productivity consists of, even inside single organisations (Forsberg, 2008). It is even possible that different companies within the construction industry should have different foci with regard to productivity, profitability and performance.

6.1 Resources, cost for the use of resources and value added

To understand the various approaches to improving productivity terms that are often used to describe productivity have been examined. How they relate to productivity is illustrated in Figure 3.3. It is argued that the 'cost for the use of resources' is a sacrifice of tangible and intangible input resources (activities) to generate output resources (products or services) through a transformation process. In the transformation process new resources that have new values are generated. The difference between the value of the output resources and the input resources is recognised as the 'value added'. Since the value of resources is dependent on demand, the cost for consuming them varies over time. Value added must therefore be simplified when transferring resources to price and cost. On this basis resources and the value added cannot be perfectly represented by numerical models (theory of constraints, cf. Goldratt, 1990). Cost for the use of resources, and thereby their monetary value, are not realised until they are sold.

There are many ways of looking at productivity. In this thesis financial resources and time resources as well as tangible and intangible resources are looked at. By looking at Figure 3.3 from a financial resources perspective (Figure 3.4) productivity could be considered low in construction. Value will from this perspective be measured in profit i.e. the difference between the costs for the use of resources and the revenue that the product brings in. By maintaining this focus, less attention is paid to the control over the resources. This view pays attention mainly to short term costs of tangible resources. Considering that construction has been suggested to suffer from a short-term gain culture both in the literature (e.g. Gadde and Håkansson, 2001), and by the interviewees, this is suggested to be the prevalent view. By maintaining this approach productivity is by and large equated with profitability (cf. Tangen, 2005, The triple-P-model).

By instead looking at Figure 3.3 from a time perspective the low productivity in construction could be brought into question. Since value becomes more than a money measure with focus on revenue the learning outcome of projects are also be considered. From this aspect, knowledge and information transfer would also become resources as the ownership of human resources (availability of labour) is taken into consideration (cf. Womack and Jones, 2003). Education would thus be a means of increasing the intangible resource base through increased knowledge and thereby increasing input to the transformation process. The importance of knowledge transfer has been pointed out in several of the reports (e.g. Latham, 1994, Egan, 1998), but according to the interviewees has so far gained little attention in the industry.

Building further on the above reasoning the views presented in Figure 3.4 and 3.5 should be combined. The combination of the two Figures simplifies the images of the considerations that have to be taken into account in organisations when making decisions regarding the use of resources.

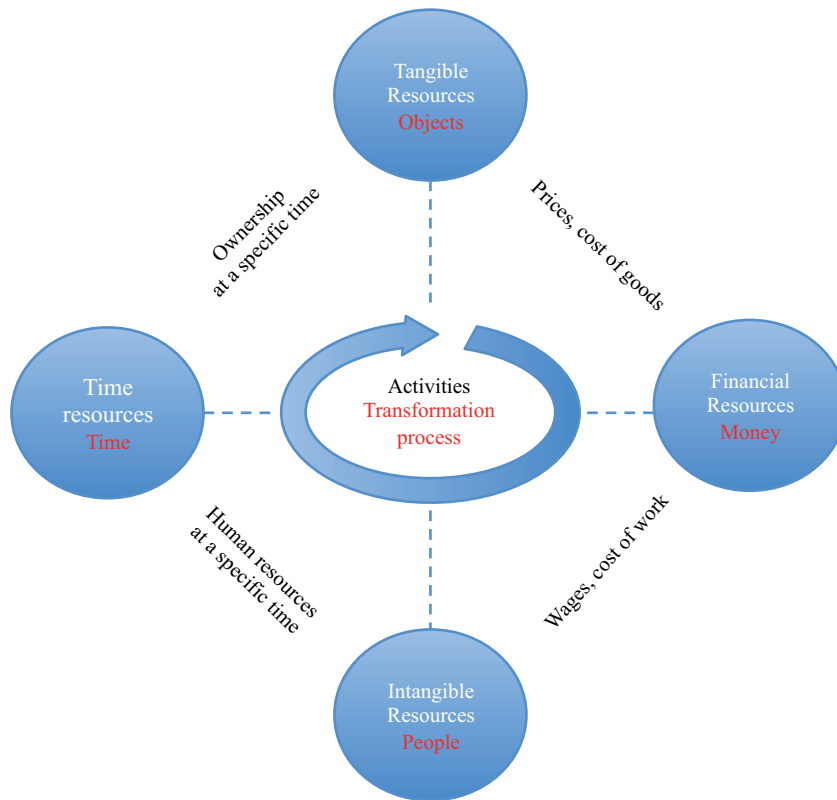


Figure 6.1. *The relation between time and money, tangible and intangible resources, in the transformation process.*

The heavy focus on price and cost (the right side of Figure 6.1) in the construction industry may hinder the actors from seeing the importance of maintaining the ownership of resources (the left side of Figure 6.1) throughout the transformation process and of the produced resources thereafter. When time is not considered costs cannot be fully depicted since they must be connected to periods (see 3.2.3). At the same time it is acknowledged that a company cannot prosper if they make no money. It is therefore argued that both time and money should be taken into consideration when evaluating productivity. Here it is argued that since production managers play central roles in project organisations, they need to have an established understanding of the importance of how to relate to resources, value and thereby productivity through considering both time and money aspects (see Figure 6.1). It is possible that this awareness will increase their understanding of the benefits to the firm also from a long-term perspective.

6.2 Production managers and productivity

One of the factors that affect productivity in construction is said to be the different foci in the temporary organisations set up for each project (Eccles, 1982,). In these autonomous ‘quasi-firms’ the production managers are in charge (Herzig and Jimmieson, 2006,). Production managers typically have to deal with a constant change of actors during the project since only a few areas of expertise are needed at

any given time. Only a few of the actors that are involved at the beginning of the project participate all the way to the end (Dubois and Gadde, 2000).

Given the production managers' important role in construction it is remarkable that the occupation, in Sweden, requires no formal training or education (Styhre, 2007). The interviews have shown that production managers' backgrounds differ widely, as does their experience. Some of the construction firms involved in the study had implemented structured programs for their employees, but this was due to decisions taken by the top managers in the organisation, not by governmental regulation or professional bodies. This could be a reason for why projects are run in different ways (Styhre, 2007), which is likely to affect their efforts to increase productivity.

According to the interviewees, differences in ways of operation were also related to their possibilities to use resources effectively, which could lead to variability in performance, also described by Thomas et al. (2002). Another possible consequence of no formal education being required among employees in construction organisations is that the construction industry may soon be facing a shortage of skilled managers, as Dainty et al. (2004) among others point out.

6.3 Improving productivity

The potential reductions in cost and time that could ensue from improved productivity in construction projects are considerable. Being able to produce more for less in the transformation process could lead to lower costs, less time used, higher profit margins and the possibility to lower prices (Koskela, 2000). But does the industry really need to change? Given the plethora of governmental reviews and reports that are churned out on a continuous basis the answer is probably affirmative. But what is the answer from the individuals working within the industry? Fernie et al. (2006) focus on change in construction and say that more understanding about the legitimacy of the managerial practices is needed so that the industry will not repeat the failures of the past. Thus, before improvements can be successfully implemented it is important to understand the industry. It is easy to agree with this argument and it underlines the importance of focusing on several approaches to the underlying processes.

Production managers in contractor organisations were chosen as the point of departure for analysing possible productivity improvements. This has provided an understanding of the perceptions of the individuals that act close to the process; where physical value is added to the product.

6.3.1 Reducing the use of resources

In this part of the discussion, aspects of the recommendations presented in paper II will be brought up from a resource use perspective. The use of resources is here related to productivity and to improving productivity to a greater degree than was discussed in paper II.

Reducing the use of resources is similar to reducing inputs in the transformation process. This in itself is not a way to improve productivity. According to the model used in this thesis, productivity is only changed if the relationship between inputs and outputs are changed. Since different views exist about which input and output factors to use when measuring productivity (Johnston and Jones, 2004), various opinions of how to reduce the use of resources are bound to exist. This is for example shown by the different variables to analyse the consumption of unnecessary resources that are

put forward in the literature. McGrath and Anderson (2000) suggest using ‘physical waste-rate’ to measure output and Saukkoriipi (2005) presents ‘directly value adding working time’ as another output measure. Both these aspects of resources could arguably be used to measure productivity. Forsberg (2008) also identifies different productivity measures. He shows that cost per square meter and cost per cubic meter are frequently used for defining labour productivity in construction.

If money is used as the main measure when considering productivity, the use of resources will be perceived to have decreased if labour salaries are decreased at constant output levels. From this perspective, poorly skilled workers who demand less wages increase productivity, which is much in line with theories of mass production (Drucker, 1991). On the contrary, if time is the only consideration, better skilled labour that is able to reduce the time used in the transformation process reduces the use of resources and thus increases productivity, in line with lean theory (Womack and Jones, 2003). It could therefore be argued that the use of unnecessary resources is low in construction processes, as every activity has meaning and includes learning aspects and therefore all resources consumed are indeed necessary. It could also be argued that most activities consume unnecessary resources, and that it is simply when a component is actually put in place that the consumed resources add value. Which of these two arguments is most convincing depends on how resources are viewed (see Figure 6.1).

To answer research question 2: *What views do production managers have concerning the firms’ productivity improvements through reducing the use of unnecessary resources?* production managers views have been considered.

When the interviewees gave their views on how their firms acted on 31 recommendations to reduce the use of resources put forward by Josephsson and Björkman (2011), six recommendations stood out as most important. These were:

1. *Define the factual customer requirements*
2. *Encourage further training*
3. *Seek long-term customer-supplier relationships*
4. *Strive for order and neatness in the workplace*
5. *Base management decisions on a long-term philosophy*
6. *Select employees with the appropriate skills and attitudes*

Six of the recommendations were also considered to be least in focus by the firms that the production managers worked at were considered. These were:

1. *Use all of the week’s 168 hours*
2. *Measure in order to uncover waste*
3. *Actively support suppliers in their development*
4. *Plan in reflection and training*
5. *Minimise weather dependency by means of pre-fabricating and weather protected assembly*
6. *Measure to control improvement work*

The difference between the two groups of resources is not easily distinguished. Both have to do with long-term engagements, which indicates that both cost and time

aspects of resources were considered. Encouraging further training, seeking long-term customer supplier relations and basing management decisions on a long-term philosophy concern both intangible and non-project bound resources. It could however be argued that the top six recommendations are connected to top management decisions, while the bottom six are more connected to the middle managers' decisions. This could indicate that the managers thought their situation and their authority at work less respected by their firms.

When instead analysing what was said in the transcribed interviews a picture of little consensus and few policies on how to encourage collaboration emerged. This conflicts with the long-term perspective that was presented as one of the more used recommendations implemented by the firms. It was maintained that top management and thereby the production managers' firm, had a strong focus on project profitability. The interviewees maintained that this culture did not promote the sharing of knowledge. Some of the interviewees even expressed frustration over that experience was not well employed by their firms. It was suggested that not enough time was given to reflection over observations. This, the managers claimed, encouraged them to adopt short-term philosophies to minimise project costs. It was argued that this behaviour inhibited attempts to standardise project processes. The apparent dissatisfaction regarding the lack of time for reflection and training and the perceived lack of interest in their insights can be interpreted as 'unused worker creativity', an unexploited resource (cf. Liker 2004).

6.3.2 Standardisation versus freedom

In this part of the discussion, aspects of freedom and standardisation as means to improve productivity will be presented. The question: *What is the relation between the production managers' need for freedom in their construction projects and the firms' need for standardisation to increase productivity?*, will be discussed from a productivity perspective, instead of as in paper III from a standardisation versus freedom perspective.

Standardisation is here viewed as the structured planning and execution of activities that have been accepted as the most effective processes. Standardisation is thus viewed to have the potential to increase productivity by reducing the input of intangible resources. By identifying what is thought to be the most resource effective transformation process also unexpected outputs might be reduced (avoidance of overproduction), which is also recognised as a possible means of improving productivity (Liker, 2004). If nothing else is affected by implementing standards, they should increase productivity both from a time and money perspective as long as costs for labour resources remain the same.

That costs for resources remain unaltered after standardisation is however difficult to achieve. An extreme aspect of increasing standardisation to improve productivity, which was brought up in paper III, is that increased standardisation might reduce production managers' motivation to such an extent that they would leave their organisation to find jobs elsewhere. If this happens the firms' intangible resource base will be reduced, and with it the ability to control the tangible and intangible resource. This loss of competence and creative potential may affect productivity far more than what can be achieved by standardising processes.

Based on this discussion, it could be expected that especially production managers, who act as leaders in autonomous organisations, would strongly argue for their need for freedom. This view has not emerged in the interviews. The main reflection from the interviews was instead that freedom and standardisation are not necessarily mutually exclusive. The interviewees even said that some standardisation in their projects would provide them with freedom by giving them time to execute other, more important, tasks.

In the interviews, the managers gave three reasons to be of specific importance for why they needed freedom. These are connected to

- The possibility to influence at what pace to work, both regarding stress-level and uncertainty,
- The possibility to influence with whom to work by being involved in assembling the project organisation to create trustworthy teams and
- The possibility to influence how to work and to have authority to affect the project, its planning and its schedule

The interviews showed that these freedom factors do not necessarily lead to a non-standardised approach. Instead, the managers argued that the short-term profit approach preferred by top management affected their motivation to induce standards negatively. Their primary ambition did not seem preserving freedom. Even though the project focus was part of the freedom concept for some managers, they claimed that the project focus was of little interest for identifying success factors or reasons for repeated failure.

The interviewees claimed that top management to a certain extent encouraged them to adopt a fire fighting, non-feedback approach. This was supposed to encourage production managers to do things their own way, without considering company practise. The encouragement and rewards for fighting fires instead of avoiding them was suggested to sometimes lead to rivalry between managers. If rivalry between production managers is encouraged by the organisation, it will be problematic to find the most useful standards. When a competitive company culture prevents the managers from articulating their ideas and identifying reasons for project success, it limits their possibilities of sharing and discussing effective standards with others. The managers may even feel a loss of individual freedom since they are hindered to continue in their development. Such a culture could therefore negatively influence the efforts to increase productivity while maintaining the motivation of the managers.

6.4 Focus on cost instead of productivity

Even though costs are just an element in the productivity concept puzzle, the production managers' main concern as expressed during this study was to be able to deliver positive bottom line at project completion. *"If favourable numbers are presented, you get a new project. If unfavourable numbers are presented all hell can break loose"*, was a common feeling among the interviewees. *"The bottom line is the only thing that top managers focus on"* was another statement in the same vein. The interviewees thought that far too little attention had been paid to projects that had 'black numbers' - i.e. projects that made a profit. The only question asked by top managers after a project was terminated was claimed to be *"what went wrong?"* They seldom asked *"what went right?"* The managers felt that a blame culture prevailed.

The top managers neglected to give people a pat on the shoulder or words of encouragement when projects had gone according to plan or when results were better than expected. On the contrary, it was argued to be commonplace that blame was put on individuals for poor decision-making when red numbers appeared on the income statement. During the interviews production managers stated that profits from successful projects were sometimes even hidden away from top management to be used as a buffer for future projects burdened with overruns. By avoiding to communicate occurring problems in the projects or hiding overruns productivity improvements may be difficult to recognise. Productivity improvements should therefore be directed towards improving the day-to-day activities on-site and not singularly focus on cost cutting from a financial resource perspective.

The top managers' focus on profit as the major success factor for projects was also frequently suggested to undermine production managers' willingness to cooperate and share information about how to run projects. Instead this focus from top management encouraged the interviewees to compete with each other and to conceal their experiences to gain competitive advantages instead of freely sharing them. One of the interviewees claimed that everyone wants to win. Another interviewee suggested that knowledge created in projects could be used as trade secrets to get a better chance to influence the selection of the new project they would be given. Another example of underlying competition was the suggestion by one of the interviewees that it would be interesting to measure and compare individual performances to see how large the differences in time and money actually were. This indicates a desire to show superiors that there are actual differences between production managers within the company.

Instead of focusing on reducing project costs, the costs related to preventive actions and agreements with subcontractors in the supply chain might have a higher impact on improving productivity. When comparing with the answers regarding the 31 recommendations in paper II, this is not thought to be the main priority of the firms by the managers in the study. The extension of this reasoning is, as McTavish, et al. (1996) that productivity is not improved for the whole construction process. As long as the main focus is project cost minimisation and not long term cost optimisation, the focus on improving productivity may not have desired effects.

All in all, these aspects show a lack of understanding of the bigger picture of productivity, profitability and performance. The question at what level of the organisation such a picture is obtained would be interesting to analyse in a future study. By noting this lack among the production managers, it is suggested that a better connection to the bigger picture of the terms would be favourable.

7. Conclusions

In this thesis, factors that influence productivity have been explored through reviews of literature. Initially theories about what productivity consists of have been presented from a non-construction perspective. In the latter part of the thesis theories have been related to the construction industry and the implications from a production manager perspective of introducing productivity improvements to its project environment. In the discussion, the findings from the papers and the literature review presented in chapters 2 and 4 were linked.

7.1. An ultimate measure of productivity does not exist

A main conclusion from exploring productivity is that it has a limited usefulness when improving processes or products. It has been shown that productivity measures cannot be adopted without reflecting over what is produced. Thereby, the term productivity can only be meaningful when its context is well known. If productivity is in focus, without a given context, the supplier runs the risk of producing less useful, less-sellable or less-profitable products or services.

To measure productivity is, however, still relevant. But, at what level in the organisation this should take place is still open to debate. While top managers measure profitability and performance, productivity is in this thesis seen to be the domain of middle managers. Particularly in construction this divide is of use since middle managers are close to the on-site transformation process, have a great deal of authority in their projects and considerably affect project outcomes. By asking for financial measures, quality measures or time measures in a productivity equation, top management can guide the production managers to achieving expected results.

7.2 Improved productivity through reducing the use of resources

By reducing the amount of the resources required in the transformation process to produce similar outputs is a means of improving productivity. Even though the statement is trivial it is clear that different aspects of resources must be considered when relating them to productivity. Both tangible and intangible resources should be accounted for in the input and output variables and further related to the transformation process, both from financial and time resource perspectives. To evaluate them in relation to each other is not easy. In this evaluation, the production managers can play an important role. Since they are close to the transformation process, they are able to identify the use of resources from the necessary perspectives. If production managers do not think about productivity a project's profitability may take over and constrain the success variables on individual projects to cost cutting.

Maintaining a short-term perspective may induce a lack of urgency for reducing the use of resources that would benefit the firm in the long-term perspective. As the interviewees' main priority was to deliver projects on time and on budget the holistic approach of the benefits to their firms was not considered. A conclusion here is therefore that the potential cost savings that may be obtained by reducing the use of resources through more standardised components, better planning or gathering and using experience systematically had not been fully examined.

7.3 Improved productivity through increasing standardisation

The managers in this study argued that the implementation of standards would in most cases not affect their feeling of freedom. Instead, they claimed that by standardising parts of the construction process the root causes to recurring problems can be solved. Governmental rules and regulations that state how salaries should be regulated, how many work hours that make up a week, what safety equipment that has to be used to avoid accidents or how certain contracts should be set up were identified as standards that have been implemented in the Swedish construction industry without changing the production managers' perceived freedom.

The managers felt that implementing more standards could even increase their sense of freedom. It was for example argued that standardising the paperwork of projects could release time that could be devoted to more important work. Also, ordering of materials was seen as taking time away from other tasks. It was argued that less qualified personnel could perform these tasks. By avoiding these tasks, the production managers claimed to be able to maintain a better overview over the activities on-site.

The conclusion is that it seems to be the possibility to maintain an overview and to influence the projects that create perceived freedom for production managers. This perception is strengthened by the observed freedom factors that were recognised as the most important for the managers in the study: the possibility to influence at what pace to work, both regarding stress-level and uncertainty; the possibility to influence with whom to work by being involved in assembling the project organisation to create trustworthy teams; and the possibility to influence how to work and to have authority to steer the project, its planning and its schedule.

Based on the above, freedom and standardisation are not necessarily mutually exclusive for production managers. They do not even have to affect each other (from a production manager's perspective). Instead, standardisation should be implemented slowly using a bottom-up approach so that the standards do not affect the managers' ability to overview and to some extent controls their project.

The results of the study show that the short-term focus on project profitability by top management decreases the production managers' willingness and ability to standardise their projects. Short-term project focus could even further distance the managers from each other and from their firms. This would underline their perception that construction projects are unique and further prevent the use of existing feedback systems. A concluding remark is that it could well be this misconception that leads to production manager demands for increased freedom to influence the projects and to run them as if they were their own firms.

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Paper I

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Exploring the Complexity of Productivity in Construction

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Exploring the Complexity of Productivity in Construction

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Abstract

Productivity is a complex term for which there is no clear definition. This is reflected not only in the daily use of language but also in scientific literature. Terms like efficiency, effectiveness, and performance are used interchangeably with productivity. The purpose of this paper is to explore the complexity of productivity in construction and to disentangle the terms and their link to productivity by providing a historical perspective and presenting theories from peer-reviewed literature. Based on this literature, some common definitions have been amalgamated and key issues have been identified for discussing and interpreting the concept of productivity. Most companies focus on profitability in order to satisfy the needs of shareholders, which means that short-term financial goals are placed before long-term productivity considerations. The paper contributes to the discussion about productivity from the perspective of those involved in the construction industry.

Keywords: Productivity, effectiveness, efficiency, performance, profitability, construction industry, complexity, perspectives.

Introduction

The high cost of construction has been debated for a long time. Reducing costs is currently a priority for the sector as well as for individual companies. The following statements from top managers in major construction companies support this contention.

"Reduced costs is the most important issue in the civil engineering sector"
Mats Williamson, former CEO of Skanska Sweden, www.fiasverige.se 22 April 2008

"We have decided a difficult, challenging and ambitious goal in reducing the cost of construction by five per cent per year in the next five years. And it does not mean to reduce the standard, because that means that you reduce the quality of the end product" Tomas Carlsson, CEO NCC Construction Sweden, www.byggindustrin.com, 28 Nov 2007.

In terms of productivity, the construction industry is often criticised for its slow pace of improvement. Productivity is, however, a complex term that raises many different issues. A literature review of productivity identifies problems in the various scientific categorisations and individual understandings of

productivity. Due to these differences no prevailing universally accepted definition can be identified.

However, there does appear to be an agreement that productivity includes comparing outputs and inputs and in recent years the debate has turned towards which of them should be compared. Economists, engineers and technologists have different professional understandings of productivity and therefore focus on different aspects of the value creating process. When focusing on productivity it is therefore important to be clear about for whom and for what purpose productivity is being measured. Different understandings and categorisations of productivity provide a variety of suggestions as to what may be included in the term.

The purpose of this paper is to explore the complexity of productivity with regards to construction. The paper begins with a historical background in order to learn how the perception of productivity has changed over time. To illustrate the complexity of productivity, individual, professional and organisational categories of productivity are presented. The terms efficiency, effectiveness and performance, often used interchangeably with the term productivity, are described and their relationship to productivity explored. Finally, it is suggested that companies within construction should consider both efficiency and effectiveness when dealing with productivity and relate them to the iron triangle of time, cost and quality in a way that can be assessed by all actors within construction.

A Historical Background

From an etymological point of view, the term productivity derives from the French word "productif" first mentioned in 1612. This word in turn stems from the Medieval Latin word "productivus", which means, "fit for production" (Harper 2001). Tangen (2005) and Kinnander and Almström (2006) maintained that the word productivity was first used in 1766 by François Quesnay, a French economist of the Physiocratic school, in the *Journal de l'Agriculture*. Harper (2001) stated that the word appeared for the first time in 1809 and was then defined as the "quality of being productive." He further explained that in 1899 it was defined for the first time in an economic sense as the "rate of output per unit."

Until the Industrial Revolution in the late 18th century, productivity was associated with the productivity of land, especially in an agricultural context. Modern technical advances contributed to that productivity of land after the industrial revolution became less important, Tangen (2004). The productivity of land can be increased by modern agricultural methods. Therefore, economic well-being is no longer necessarily dependent on the productivity of land, Pritchard (1995).

The shift from agriculture to industry caused by the Industrial Revolution was accompanied by a shift in use of the term. These days, in the industrialised parts of the world, the term productivity is most commonly related to the productivity of labour (Forsberg, 2008; Pritchard, 1995). During industrialisation, a country moves from low productivity and low income to high productivity and

high income; this transition takes time, Clegg et al. (2005). Figure 1 illustrates the different steps of the transition process. The starting point is the state of low productivity and low income. Technical innovation and the development of new processes lead to new products and services that encourage the establishment of new industries, which in turn lead to increased labour productivity. In comparison with the previous state, this leads to an increase in output, which in the long run achieves a state of higher productivity and higher income. The whole process is iterative and can also be used to explain the development of countries.

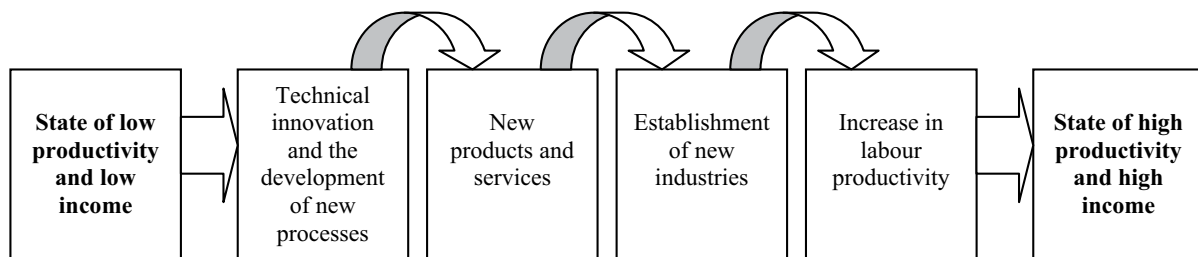


Figure 1: The Four Steps to Increase Income and Productivity (Developed from Encyclopædia Britannica inc., 2009)

It is only since the beginning of 20th century, when organisational scientists started to study organisational structures, that productivity was recognised as an important organisational measure (Pritchard, 1995; Ghobadian and Husband, 1990). According to Rämö (2002), Taylor's ideas, presented in 1911 led to the "revolution in manufacturing" and the development of facilities for mass production. Since Taylor's "Scientific Management", numerous other theories have been established; all with different views regarding the question "how to optimise labour productivity" (Clegg et al., 2005). Pritchard (1995) claimed that, since the 1970s, numerous scientists in the field of behavioural science have focused on productivity. The diversity in definitions is identified as the main reason for the difficulty of disentangling the term productivity.

Definitions of Productivity

No predominant definition of productivity can be identified. Instead, different aspects of productivity are presented. The different definitions found in the literature underline the complexity of the term. A common idea is the relationship between the use of resources and the gains of value, and output compared to input. The literature also identifies the measurement of productivity by focusing on labour. The definitions from the 21st century contain more specified contextual elements and fewer formulas. There is a general discussion regarding the question of which inputs and outputs to compare, as well as whether different organisations need different measures (Forsberg, 2008; Tangen, 2004).

THREE UNDERSTANDINGS OF PRODUCTIVITY

The individual understandings of productivity described by Ghobadian and Husband (1990) identified three main categories.

- The engineering understanding
- The economist understanding
- The technological understanding

Each understanding finds applicability with certain individuals on the basis of their different professions (Ghobadian and Husband 1990, Sink 1985). To further elaborate on the understandings a model by Johnston and Jones (2004) is utilised. The model was used in a different context and for the purpose of this paper been dismantled so that each understanding can be examined separately.

The Engineering Understanding. Individuals with an engineering background often use the engineering understanding; it is inherent in their way of thinking. This understanding focuses on the relationship between actual and potential outputs of the inputs and their conversion process (Figure 2). The actual process is the key element in this concept.



Figure 2: The Engineering Understanding

To explain the three understandings with the aid of a practical example, the combustion engine is taken. From an engineer’s point of view, increasing productivity would mean looking at the utilisation factor of the engine. Theoretically, all energy in the fuel before combustion can be transferred into kinetic energy after combustion. This is not the case; most of the energy is transferred into heat and therefore lost without being used. Increasing productivity from an engineer’s point of view would mean to try to increase the utilisation factor.

The Economist Understanding. Individuals with an economic background commonly hold this point of view. Its main focus lies on the financial resources that are allocated for processing inputs into outputs. Of special interest are the financial means used (inputs) and the gains that emerge (outputs) by the process. Figure 3 simplifies the economist understanding. Inputs are exemplified as the cost of human resources, for example cost for labour and other resources like renting machines and buying materials. The outputs are exemplified as revenue, profit and value added.

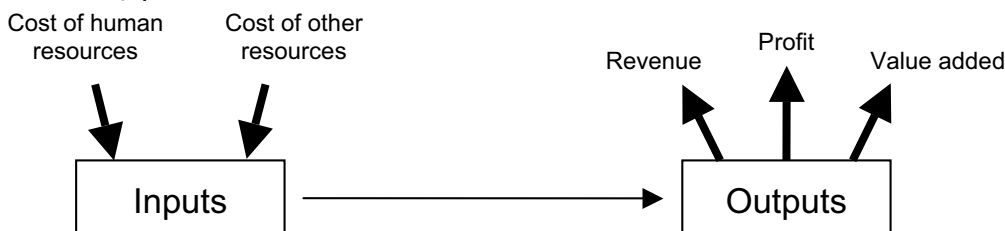


Figure 3: The Economist Understanding

In the combustion engine example, the economist would look at the costs for running the engine and compare them with the financial outcomes gained from doing so.

The Technological Understanding. Individuals with a practitioner's background are often subscribed to this view. Productivity is viewed as the ratio of non-financial outputs to non-financial inputs used in the production process; see Figure 4. The non-financial inputs contain measures such as the number of customers and the units of human resources or units of other resources. The non-financial outputs can be exemplified as the units of human resources consumed, the units of other units consumed, the number of goods or services sold, and the number of customers processed.

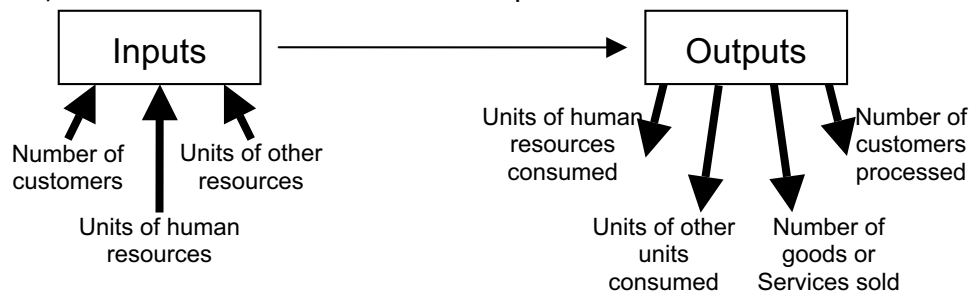


Figure 4: *The Technological Understanding*

Looking at the combustion engine once more, the non-financial inputs can be viewed as the amount of fuel before use and the non-financial outputs as the amount of fuel left in the fuel tank after the engine had been run. The means of increasing productivity from a technological understanding is to decrease the inputs and/or increase the outputs.

When looking at these three understandings, it is evident that misunderstanding and misinterpretation can easily emerge. The reason is that, in practice, it is unrealistic to distinguish between the three understandings because to some extent they are mixed and synthesised.

THREE CATEGORIES OF PRODUCTIVITY

A definition presented by Pritchard (1995), focuses more on what to include when measuring productivity. A different viewpoint is taken and this categorisation is therefore detached from the individual understandings given above. It distinguishes between three categories of productivity as shown in Table 1.

Table 1: *Three Categories of Productivity (from Pritchard, 1995)*

Category I	Productivity is a measure of outputs divided by inputs.
Category II	Productivity comprises the two dimensions of efficiency and effectiveness.
Category III	Productivity essentially includes any characteristics that make the organization function better.

Productivity in terms of Category I is usually measured in cost or units in order to allow interpretation and comparison across different settings. The productivity measurements in Category I solely concern the ratio between the inputs that have been used and the outputs that have been generated. Other important

factors of the organisation are not considered. Numbers of m³ concrete, m² gypsum boards or m² tiles or their respective monetary value are examples of output measures, whereas raw materials, labour, machinery or energy are examples of input measures.

Category II introduces the terms efficiency and effectiveness. Efficiency is defined as the ratio between input and output, which can be equated to Category I. Effectiveness, in turn, can be translated as "...the ratio of outputs relative to some standard or objective." Pritchard (1995) expressed in simplified terms, that Category II establishes a link between the output/ input measure and a reference value to which this measure needs to be compared.

Category III broadens the scope of the two previous definitions. Based on the second category, it takes a number of additional factors into account. Category III "...essentially includes any characteristics that make the organization function better" Pritchard (1995). Examples of this are, besides effectiveness and efficiency, quality of output, work disruptions, absenteeism, turnover and customer satisfaction.

The question of which of these categories is the most applicable in construction is controversial; caution is imperative when using the term productivity. Some individuals may rightfully claim that the definition used is not valid or not in accordance with their view. To avoid this, Pritchard (1995) argued that agreement should be reached on what productivity comprises before any measurements of it are made.

SINGLE FACTOR PRODUCTIVITY AND MULTI FACTOR PRODUCTIVITY

Calculating productivity as the ratio between outputs and inputs can be done in various ways. The simplest model found in the literature is single-factor productivity. This measure takes one factor of each input and output into account. The more sophisticated value is that of multi-factor productivity, where numerous factors are considered (Crawford and Vogl 2006). A common single-factor productivity measure is the average labour productivity (ALP). Crawford and Vogl (2006) explained that ALP is calculated by dividing an output measure, usually gross value added (sometimes also gross output), by labour input, which is usually given by the number of workers or hours. An example of a common multi-factor productivity measure is total factor productivity (TFP). Using the concept of a production function can depict TFP measures.

$$O = A \cdot f(C, L, M) \quad \text{Equation 1 (developed from Crawford and Vogl, 2006)}$$

This equation shows how output (O) and inputs (Capital (C), Labour (L) and Material (M)) are related. $f()$ is a function that gives the output for specific inputs. A is the so-called "shift-factor" that

"...represents technological progress in the production of outputs for a given set of inputs. These include the quality of management, knowledge and techniques, and best practice in various production activities. A is assumed to be 'neutral' in that it acts by shifting the production function $f()$, not by augmenting a particular input."

Crawford and Vogl (2006)

Crawford and Vogl (2006) favour multi-factor productivity over single-factor productivity. They suggested that "...the simple-to-calculate output/labour input ratios used in most studies do not enable the establishment of robust cause-and-effect relationships, leaving the reader largely in the dark about drivers of performance and their relative importance." Instead, a suggestion is made to establishing a robust measurement framework with the goal of being able to "...explain as much as possible of construction output in terms of the resource inputs used to generate it" (Crawford and Vogl 2006).

Multi-factor productivity measures can be considered more precise than single-factor measures as they take more dimensions into account (Crawford and Vogl, 2006). However, the conflict that occurs when accumulating different aspects into one value is an issue that still needs to be resolved. Further research is needed to fully understand how to measure, what to measure, and how to use those measures. Another aspect that needs to be discussed further is how applicable or practical the measures are, to whom the measures are directed, and how different individuals interpret them.

No uniform definition of the term productivity has been found. This complexity and multipurpose use causes confusion. Interpretations and implications of the term differ from individual to individual, company to company and industry to industry, Tangen (2004). The lack of a clear definition makes it complex and difficult to assess what input and output ratios to use when measuring productivity.

Concepts Related to Productivity

The terms efficiency, effectiveness and performance will in this section be regarded as dissociated from the term productivity even though numerous authors use the four terms interchangeably. There seems to be no uniform understanding of how to distinguish between the terms. This differentiation will be the basis for the suggestions of what to contain within the term productivity so that it can more easily be agreed upon.

Performance. According to Oglesby et al. (1989) and Sink (1985), productivity is one aspect of performance. Oglesby et al. (1989) stated that "the word 'performance' involves all aspects of the construction process." They further argued that productivity is mainly connected to activities on the construction site or activities that directly influence that work. Oglesby et al. (1989) attributed four main items to the term performance: productivity, safety, timeliness, and quality. This partly corresponds to the seven criteria that Sink (1985) identified as constituting performance. He argued that effectiveness, efficiency, quality, quality of work life, innovation, profitability, and productivity are aspects of performance. Tangen (2005) stated that performance is a

"...term that covers both overall economic and operational aspects. It includes almost any objective of competition and manufacturing excellence whether it is related to cost, flexibility, speed, dependability or quality ... Furthermore, performance can be described as an umbrella term for all concepts that considers the success of a company and its activities.

Nevertheless, the types of performance that a particular company strives to fulfil are very case specific.”
(Tangen, 2005)

This indicates that there is no common definition for the term performance, either. The literature agrees that performance constitutes various aspects, although there seems to be no agreement over what these aspects are. Therefore, the definition should be kept rather broad instead of adding specific aspects that might limit the definition. In this sense, the definition by Tangen (2005) is the most applicable as it is possible to relate the presented differentiation to the three categories of definitions for productivity presented above. For the purposes of this paper Category III is not seen as dealing with definitions of productivity but rather with performance. This leaves Category I and II, and to further limit the scope of productivity, it is necessary to differentiate between efficiency and effectiveness.

Efficiency. The Oxford English Dictionary Online (2008) defines the term efficiency as “the ratio of useful work performed to the total energy expended or heat taken in.” Pritchard (1995) drew on Max Weber’s idea of bureaucracy where efficiency is defined as “maximum output with minimum input.” These two definitions can be equated with Category I. Sink and Tuttle (1989) defined efficiency as doing things ‘right,’ which can be interpreted as singularly looking at the output/input factor of a process without comparing it with other processes or looking at the value added. Sink (1985) defined efficiency as “... the degree to which the system utilized the ‘right’ things. ” Tangen (2005) stated that efficiency is:

“...often linked to the creation of value for the customer and mainly influences the numerator (outputs) of the productivity ratio. A good, simple description of effectiveness is ‘the ability to reach a desired objective’ or ‘the degree to which desired results are achieved.’” (Tangen, 2005)

Achabal et al. (1984), quoted by Keh et al. (2004), took the definition one step further. They discussed the use of input resources and how to optimize the ratio between output and input. They stated that:

“efficiency deals with the allocation of resources across alternative uses ... [it] is achieved when the marginal productivity per unit of price is equated across all resources that contribute to the firm’s output. Another way to look at efficiency is, given a level of output, how does the firm minimize input?”
Achabal et al. (1984), quoted by Keh et al. (2004)

As these definitions generally point in the same direction, it can reasonably be deduced that a common understanding of the term efficiency exists. This can be compared to Pritchard’s (1995) Category I (see Table 1).

Effectiveness. The Oxford English Dictionary Online (2008) defines effectiveness as “The quality of being effective (in various senses).” To be effective can, in the context of this paper, further be defined as “Having the power of acting upon the thing designated.” (Oxford English Dictionary Online, 2008). Pritchard (1995) provided a more specific definition by claiming

effectiveness to be "...the ratio of outputs relative to some standard or objective." Keh et al. (2004) quoted Achabal et al., (1984) who stated that

"... the effectiveness question is concerned with determining which retail strategy, among all possible strategies, maximizes long-run ROI. This search for the most effective use of resources assumes resources are used efficiently" (Achabal et al., 1984, quoted by Keh et al., 2004)

Sink (1985) defined effectiveness as "the degree to which the system accomplishes what it sets out to accomplish," whilst Sink and Tuttle (1989) defined effectiveness as doing "the 'right' things, on time," when doing the right thing is compared to other related processes and the bigger picture in order to make sure that value is added. According to (Tangen (2005), effectiveness "...is commonly defined as the minimum resource level that is required to run the desired operations in a given system compared to the resources actually used." As the definition of efficiency ranges somewhat, it can be maintained that effectiveness comprises a comparison between an actual output and a reference value that has been defined beforehand.

DIFFERENT DEFINITIONS OF PRODUCTIVITY FOR DIFFERENT INDUSTRIES

The apparent diversity and complexity of productivity presented in the literature, makes it hard to find a common denominator for the use of the term for all industries. Different industries use different definitions because inputs and outputs vary greatly, as do business objectives (Pritchard, 1995; Tangen, 2004; Forsberg, 2008). This can be illustrated by an example of measuring labour productivity: Forsberg (2008) compared labour productivity of a car manufacturer (SAAB) and a construction company specialising in the production of prefabricated timber houses (Älvsbyhus). SAAB measures productivity in terms of cars produced per employee per year, whereas Älvsbyhus measures productivity in terms of the production cost per built house (Forsberg and Saukkoriipi (2007).

The categorisations show how distinct the viewpoint of different authors is, and the complexity of comparing between industries. The complexity increases when considering Category III, which essentially suggests that productivity cannot be regarded in isolation but should be contextualised and include any characteristic that makes the organization function better. Pritchard (1995) identified the three categories but claimed that it should be agreed upon beforehand what the term productivity should comprise. In this regard, Category III is seemingly too complex and broad to be considered a suitable base for defining productivity in the construction industry.

Discussion

The suggestion of what to include in the term productivity for the construction industry should not only disentangle connected concepts and lessen the complexity of the term, but also establish the basis for further discussion and for the creation of "tools" suitable for use by all actors in the construction industry.

According to Sink and Tuttle (1989), productivity should be viewed as an important aspect of total performance. Category II defines productivity as comprising the two dimensions of efficiency and effectiveness, both of which should be used as the baseline for measuring productivity, even though aspects such as quality and profitability may also be included. This category of definition suggests that an input/output measure (efficiency) needs to be compared against reference data (effectiveness) and is preferred for the paper since a singular comparison between input and output is of little use unless related to pre-assigned values and viewed from a broader perspective.

Tangen (2005) developed a model to link the terms. The triple P-model, presented in Figure 5, takes into account performance, productivity, efficiency, effectiveness, and profitability. The model is divided into the two dimensions of input and output with productivity forming the centre. Moving from the centre towards the outer rims, the dimension of profitability is added. "Profitability [in the model] is ... a monetary relationship in which the influences of price-factors (i.e. price recovery) are included" (Tangen 2005). The outer rim of the model is the performance dimension. It includes both productivity and profitability.

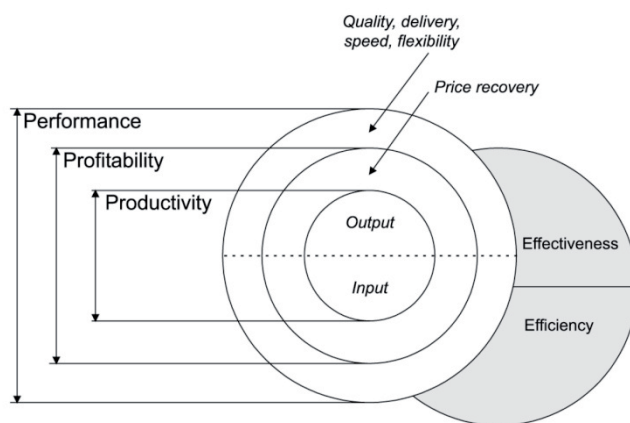


Figure 5: The triple P-model (Tangen, 2005)

Tangen (2005) stated that effectiveness and efficiency are:

"...somewhat cross-functional when it comes to the other three terms. Effectiveness represents the degree to which desired results are achieved; Efficiency represents how well the resources of the transformation process are utilized."
(Tangen, 2005)

The dimension of profitability as depicted in the triple P-model suggests that productivity is closely linked to profitability. This is not in line with the viewpoint of the authors of this paper. Productivity, as the definition by Tangen (2005) suggests, consists not only of the dimensions of effectiveness and efficiency but also of different individual viewpoints, which increases the complexity. Profitability is merely economists' understanding and is not representative of individuals' definition of productivity. To get a more holistic view of productivity, profitability should be added as an aspect of performance. To add the aspect of construction to the concept of productivity it is suggested to make use of the iron triangle of time, cost and quality, as presented by Atallah (2006) and Santos et al. (2002). By connecting already defined key issues known to all actors in construction the complexity of the term productivity may be reduced.

Conclusion

All aspects of productivity, historic, individual, professional and scientific, should be used when exploring the complexity of productivity. Based on the reviewed literature, the following aspects of productivity are suggested as a way of reducing its complexity so that all construction participants can understand it. In line with the argument of Pritchard (1995), the suggestion focuses on applicability with the understanding that the term has to be agreed upon by all actors before it can be effectively used.

Productivity is suggested to consist of the twin dimensions efficiency and effectiveness. The former constitutes the ratio between measures of input and output, whereas the latter gives a pre-assigned value to compare against and relate to. Without the benefit of comparison, a meaningful conclusion is difficult. However, it is reasonable to assume that most productivity measures are carried out for the sake of optimising time, cost and quality, and that it is important for all actors in the construction industry to understand and be able to use the measures.

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Paper II

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Reducing the use of resources in construction

Submitted to journal

REDUCING THE USE OF RESOURCES IN CONSTRUCTION

Pim Polesie¹

Abstract

In this article what construction firms do – and do not do – to reduce the use of resources are explored by adopting a middle management view of their firms' activities.

The article is based on empirical data; fifteen production managers have been asked to indicate how they perceived how their company complied with thirty-one recommendations to reduce their use of resources.

The findings show that managers perceive their firms focus on identifying their customers' real needs, stimulating employees to undertake further education, and striving for long-term customer-supplier relationships. In contrast, they perceive that less attention is directed to making use of all of the week's hours, to supporting their main suppliers in their development, and planning-in feedback and training after project completion.

Based on the findings the use of resources is discussed by concentrating on the perceived low priority given to gathering information and knowledge, as well as to reducing time and the need for long-term relationships with customers in contrast to short-term relationships with suppliers.

The results indicate that the managers adopt a project-specific approach to the use of resources, mainly material resources. It is suggested that a more holistic view of resources could enable the development of novel solutions.

KEYWORDS: cost reduction, leadership, production manager, resource reduction.

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Introduction

In order to ensure long-term productivity, manufacturing firms try to reduce the use of resources in the development and use of their products. Economic as well as environmental aspects motivate that less resources should be used to achieve comparable results. But, unlike manufacturing, construction does not, for the most part, produce long series of standardised items in factory environments (Koskela, 2003). Instead, the emphasis has been on understanding and improving production capabilities in the specific circumstances of each project (cf. Dainty and Brooke, 2004, Winch, 2006). Therefore, direct translations of the manufacturing industry's recipes for reducing resource use are not always applicable in the construction industry. Still, the need to reduce the use of input resources has for some time been accepted in construction practice as well as in the academic debate (cf. Egan, 1998, Fearne and Fowler, 2006, Winch, 2006). The various suggestions on how to reduce resource use have created a cocktail of definitions and measures to coexist.

Even though awareness for the need to change towards an increased focus on reducing the use of resources exists in construction industry (cf. Faniran and Caban, 1998, Treloar et al., 2003, Dainty and Brooke, 2004), the literature in general reports a resistance to such change (Fernie et al., 2006). One example is Teo and Loosemore (2001) who argue that a sense of pragmatism and unavailability concerning material waste prevails amongst those engaged in construction. Another example is Green and May (2005), who argue that a general short-term focus combined with risk aversion among middle managers renders extensive change aimed at reducing resource consumption unlikely. It is even argued that a pragmatic short-term approach to resource consumption could be counterproductive since long-term profit gains are not taken into account.

Even though the construction management literature presents a number of actions that construction companies should adopt in order to improve, few cases of what is actually done and how the employees espouse these actions have been found. If the employees are not involved in the process of reducing resource use, any recommendations for such actions could prove ineffectual (Floyd and Wooldridge, 1997).

This article probes into how production managers, working on-site, perceive their firms' efforts to reduce the use of resources. It departs from descriptions of the multifaceted literature on the use of resource and illuminates concept entanglements that production managers have to relate to in their daily work. The findings are drawn from structured interviews with fifteen production managers in three medium-sized contractor organisations. Thirty-one recommendations to avoid the unnecessary use of resources, developed in collaboration with the industry, provided the foundation for the study.

Unnecessary use of resources

Unnecessary resources in the literature are repeatedly referred to as both physical resources (scrap, garbage) and non-physical resources (activities, processes, rules, storage) that are used as inputs into a process but are not transferred to valuable outputs. Generally, literature focus is on one of these aspects, often without clearly

establishing distinctions between them. This is a source of confusion when focus is on using input resources more effectively and to avoiding output resources that add no value. Terms commonly used interchangeably with “unnecessary use of resources” are for example ‘non-value adding activities’, ‘waste’, and ‘poor quality’. Some terms may be applicable to both physical or non-physical resources, others to one only. Similarly, the unnecessary use of resources in this study deals with both activities (non-physical) and materials (physical) that do not add value to the output product or service (e.g. Buzby et al., 2002).

The various views on waste illustrate the muddle existing in the literature. They range from non-value adding non-physical resource consumption to over-production and physical debris. The established classification of non-physical resources as value-adding activities, necessary but non-value adding activities, and non-value adding activities represents one side of the definition (Hixon, 1995, Hines and Rich, 1997, Womack and Jones, 2003). Common interpretations of unnecessary use of resources from this perspective are any activities which absorbs resources but creates no value (Womack and Jones, 2003) and activities that absorb resources without adding customer value (Liker, 2004). By focusing on removing non-value-adding activities instead of trying to speed up the value adding activities, the above sources argue that time and thereby costs can be reduced without interfering with product quality. At the other end of the “waste” definition spectrum Faniran and Caban (1998), Treloar et al. (2003) and Dainty and Brooke (2004) confine their definition of waste to the physical resources that are thrown away and those that are consumed but do not end up being used in the final product.

There are also sources that bridge the gap between the two extremes. E.g. Hixon (1995), argues that waste is anything that can be eliminated without detriment to the final product or service. This definition opens up for alternatives that are not directly connected with non-physical aspects such as activities. Also Formoso et al. (2002) with their focus specifically on the construction industry define waste from a broader perspective “... as the loss of any kind of resources – materials, time (labour and equipment), and capital – produced by activities that generate direct or indirect costs but do not add any value to the final product from the point of view from the client” (ibid. p.317). Thus they incorporate both the abovementioned aspects of the use of resources.

Unnecessary use of resources also commonly refers to the inefficiency of the organization (e.g. Love and Edwards, 2004, Fearn and Fowler, 2006), skill shortages among construction workers (e.g. Dainty et al., 2005, Clarke and Herrmann, 2007), and - from a manufacturing perspective (Liker, 2004) - the unused creativity of the employees.

Unnecessary use of resources has also similarities with the concept of quality costs, commonly defined as costs which would disappear if the company’s products and processes were perfect (Juran, 1989). Using costs instead of activities emphasises that there are losses that are overlooked when considering only the activities and not their consequences. The quality management literature (e.g. Juran, 1989) as well as the lean production literature (e.g. Formoso et al., 2002, Liker, 2004) are unanimous in arguing that reducing unnecessary use of resources is the best way of improving an organization’s processes, competitive advantages and profits.

Reasons for unnecessary use of resources

Means of avoiding unnecessary use of resources have been developed from diverse interpretations from manufacturing, which historically have gained attention. Some examples are the use of ideas from Taylorism and Lean production. These ideas have been understood in different ways and given rise to new questions and new fields of research. As an example, Green and May (2005) argue that 'lean construction', developed from lean production, is frequently conceptualized, manifested and enacted differently in different arenas. But by in this way applying theories developed in other disciplines the complex structure of the construction industry might not be taken into account (Seymour and Rooke, 1995, Jørgensen and Emmitt, 2008). Theories that have proven effective in the manufacturing industries may become ineffective when applied in construction. An example of why some of the ideas from manufacturing that have been suggested in the literature have gained little response in construction is the perceived uniqueness of the construction industry (e.g. Business-Roundtable, 1982, Egan, 1998, SOU, 2009:6). There are various aspects to take when focusing on resources; some common used aspects are brought up in the following.

Cost resources. The focus on cost and thereby monetary resources often originates from the use of materials - the physical side of resources. Studies that use this approach focus primarily on costs that are linked to material waste or that is thrown away on construction sites and on strategies related to minimizing this waste.

Dainty and Brooke (2004) interviewed 27 waste specialists from UK construction who stated that waste in construction was too high. 60% of their respondents maintained that more needed to be done in order to improve performance. In another study of twenty-four construction firms in Australia, Faniran and Caban (1998) found that only 57% of their respondents claimed to have policies in place for minimizing material waste. They found that even though firms claimed they had implemented routines for reducing such waste the sources of the waste often remained unexplored. They argued that waste levels were not directly dependent on the type of product or the company, but on the site and the people working on it. In particular, the site managers and site operatives were identified as key players in reducing resource consumption. It was seen that the focus on waste minimization from top management was mainly directed to "*computer transfer or drawing and information; using both sides of the paper for photocopying, and using ceramic mugs and metal spoons in place of disposables*" (p. 186) - this is remarkable and arguably slightly myopic. Even though it was the interviewees' perception of material resources that was analysed, it was the cost perspective that motivated them, which could explain the skewed image.

A broader perspective on cost can be found in the quality management literature. Studies from this field report that costs attributable to poor quality are in the region of 25-30% of the organisation's turnover (e.g. Sörqvist, 1998). Most studies in construction are, however, limited to costs of defects, rework, deviations or changes. Here also definitions, perceptions and methods for collecting data vary to such extent that it becomes difficult to compare empirical results. The various results show that the studies are greatly influenced by how the researchers carrying out the studies saw and defined waste.

Knowledge resources. For example, Fearne and Fowler (2006) as well as Hines and Rich (1997) suggest that lack of knowledge of the construction processes is a

substantial factor in causing unnecessary use of resources. The use of resources within this approach is applicable to both tacit and explicit resource utilisation but from a knowledge perspective. It thus partly bridges the manager-worker gap which is often mentioned in the management literature in the literature (Ferne et al., 2006) by considering the value of both the workers' and the managers' knowledge.

From a construction perspective, knowledge is commonly connected to the ability to avoid upcoming uncertainties. Koskela and Vrijhoef (2001) argue that managers in construction focus on tackling upcoming uncertainties instead of seeking the root causes to why the problems occur and positioning themselves so that the problems would be completely avoided. It has been suggested that the use of the firm's knowledge resources are thus limited to the managers' ability of fighting fires instead of ensuring that they are avoided (Styhre, 2007).

Winch (2002, 2006) argues that both complexity and unpredictability are identified as major reasons for resources use in construction projects. Mills (2001), who maintains an on-site approach agrees that the industry suffers from a high level of uncertainty and argues that variations in weather, labour productivity and materials quality are some of the determining factors for the uncertainty. It is argued that increased knowledge among the individuals could reduce the risks associated with some of these factors. Craig and Sommerville (2006) give an overview of the construction process and argue that the uncertainty is dependent on the difficulty of maintaining operational information systems, which relates directly to the knowledge aspect.

When combining the different reasons for the consumption of unnecessary resources, it is clear that there is a lack of consensus on definitions. In the reviewed literature a lack of information of how the data was collected and little consensus concerning fundamental questions, e.g. what is value-adding work, was discovered. Illustrative examples are studies showing exact figures for value adding work and the cost of rework, etc; thereby leaving the reader with a false sense of reliability and validity. The diverse meanings given to waste indicate the importance of critically questioning how the studies have been carried out. Furthermore, the different approaches to minimising the use of input resources lead to a variety of solutions and thus different figures and numbers.

Instead of studying specific organisational patterns of behaviour and linking them to established theories in the manufacturing industry, this article focuses on how individuals working in construction perceive their organisations' attempts to deal with unnecessary resource consumption. To put the discourse about the various approaches to reducing resource use into perspective, the following section reviews the role of the production manager in construction. It has been argued that middle managers in construction control the transformation process (where resources are consumed) to a larger extent than do managers in manufacturing (cf. Koskela, 2000, Smith, 2001).

Production managers' role in construction

Even though production managers have been described as the people who carry the responsibility for on-site activities (e.g. Djebarni, 1996, Chen and Partington, 2006, Styhre, 2007) where value is created as well as acting as representatives of the client in the production phase, they are still given little attention in the academic debate. Given their strong influence on the success and failure of construction projects, and the extensive academic debate about the importance of reducing the use of resources,

it is remarkable that so few studies have focused on how production managers view their firms' efforts to reduce the use of resources.

In contrast to manufacturing, construction is fragmented and projects are geographically dispersed (Eccles, 1982, Dubois and Gadde, 2002a). The duration of activities in construction are usually measured in days or weeks.

In contrast to manufacturing, where the operations are commonly measured in hours or units produced, making construction subject to variation and disruptive influences (Fearne and Fowler, 2006). This state of affairs gives rise to temporary sub-organizations within the construction firms (Koskela, 2003). The role of middle managers, as well as the set of tools they control is different to those of their counterparts in manufacturing (Holden and Roberts, 2004, Thomas and Linstead, 2002, Herzog and Jimmieson, 2006, Ivanova, 2007).

Djebarni (1996) maintains that "*it is on-site that the contractor's cash flow is generated, claims are circumvented and the reputation of companies built*" (p.281) enforces the production managers' strong influence and unique position in construction. Lingard et al. (2000) discovered that site managers do not believe that it is possible to effectively manage solid waste on construction sites. According to Djebarni (1996) their negative attitude to the possibility of using resources more efficiently on-site could be particularly unbeneficial since production managers to a greater extent influence the attitudes of workers on construction sites. Lingard et al. (2000) further argue that the managers in their study tended to regard issues outside their direct control as being the most important in influencing waste management outcomes. Green and May (2005) emphasize the role of the middle managers in construction, but they also argue that in general middle managers are risk averse due to an institutionalized commitment to short-term cost reduction policies which renders comprehensive change in their behaviour unlikely.

Method

This article explores what construction firms do – and do not do – to reduce the use of resources. An exploratory approach to consumption of resources is used. The findings were obtained using a mixed method approach (Dainty, 2008), in which questions based on a set predefined recommendations for reducing the use of resources was used. The interviewees were next asked to comment on the recommendations. The recommendations were the thirty-one developed by Josephson and Björkman (2011, see Table 1). Josephson and Björkman had identified these recommendations, in discussions during a series of workshops with actors in the Swedish construction industry. The analysis of the answers drew on the systematic combining described by Dubois and Gadde (2002b) .

The participants in the present study were encouraged to respond to the questions on the basis of their current portfolio of projects. For each recommendation, the respondents were asked to indicate "*how much effort does your organisation put into achieving this recommendation*" on a continuous scale varying from "very little" to "very much". The recommendations were sorted in five categories: standardize the product based on a holistic view, sharpen and standardize the process, develop the organization and its competences, discipline the leadership and lead continuous

improvements. The recommendations relating to each category were grouped together in the interviews.

Based on the recommendations of their respective top managements fifteen managers from three Swedish medium-sized construction companies were selected for the interviews. All participants had managerial roles in production: twelve were site managers; two project managers; and one was the manager of improvement activities with focus on-site management. The responses varied somewhat in length, ranging from 35 to 45 minutes. In addition to the sliding scale answer on their company's effort on each recommendation, further information was obtained by asking the interviewees follow-up questions such as "why did you put the scale indicator there", and "how do you interpret this recommendation". All interviews were tape-recorded, and relevant sequences were transcribed verbatim (Kvale, 2007).

The obtained sliding-scale answers were transferred to a numerical scale from 0 (very little) to 10 (very much) thus making the results quantifiable (Bryman, 2008). This facilitated comparisons between the respondents' reactions to the recommendations. The generalizability of the results was verified by comparing with two reference groups that were asked to respond to the standard concepts of the structured interview. The first group consisted of 16 middle managers, mainly from large and medium-sized construction companies, and the second group consisted of 22 middle managers from a regional construction company.

Findings

Often the interviewees questioned why they had not been asked earlier to give their opinion concerning what resources should be regarded as unnecessary. They all asserted the importance of involving them in the process of identifying unnecessary use of resources since they viewed themselves as being closest to the production process. This strengthens the argument that production managers should be more involved in improvement processes (cf. Djebarni, 1996, Faniran and Caban, 1998).

Table 1: Production managers' perceptions of their companies' priorities of resource reducing activities. (STD = standard deviation)

<i>Recommendation</i>	<i>Average</i>	<i>STD</i>
<i>Standardize the product based on a holistic view</i>		
Standardize components (recommendation no. 5)	6.90	1.77
Prioritize sustainability in system choices (2)	6.87	2.26
Develop technical solutions that can be used for several products (3)	6.44	2.19
Reduce the range of components (4)	5.99	2.61
Base product definition on running costs (1)	5.86	2.64
<i>Sharpen and standardize the process</i>		
Define the factual customer requirements (6)	8.48	0.94
Seek long-term customer-supplier relationships (8)	8.37	1.98
Plan accurately and follow-up continuously (12)	7.18	1.74
Establish disciplined information structures and meetings (14)	6.83	2.07
Develop similar ways of working (10)	6.68	2.36

Oversee that all project members know and understand the project goals (7)	6.58	2.91
Standardize information management tools (11)	6.54	2.38
Structure supply flows for efficient assembly (15)	6.23	1.83
Minimize weather dependency by means of pre-fabricating and weather protected assembly (13)	4.74	2.80
Use all of the week's 168 hours (9)	3.25	2.08
<i>Develop the organisation and it's competence</i>		
Encourage further training (20)	8.39	1.44
Select employees with the appropriate skills and attitudes (17)	7.52	2.17
Support the development of individual effectiveness (21)	6.76	2.49
Strive for aligned teams and project organizations (18)	6.14	2.60
Consider new skills to meet new approaches (19)	6.09	2.63
Plan in reflection and training (22)	4.68	2.39
Actively support suppliers in their development (16)	4.45	3.00
<i>Discipline the leadership</i>		
Strive for order and neatness in the workplace (24)	7.58	2.07
Base management decisions on a long-term philosophy (23)	7.53	1.80
Give clear instructions. which cannot be misinterpreted (25)	7.04	1.99
Set high demands that drive development (26)	7.01	1.57
Reward good work (27)	6.92	2.41
<i>Lead continuous improvements</i>		
Link all improvement initiatives to product characteristics or to the value-adding process (31)	5.58	2.23
Collect and use best practices systematically (30)	5.49	2.47
Measure to control improvement work (29)	5.19	2.56
Measure in order to uncover waste (28)	4.25	2.88

Six of the recommendations were particularly interesting to the interviewees. Recommendations nos. 6, 20 and 8 received the highest scores, while recommendations nos. 16, 28 and 9 received the lowest scores. The results from the two reference groups were very consistent with these results.

Highest scoring recommendations

Define the factual customer requirements (recommendation no. 6). The managers insisted that their organisations were identifying actual customer requirements. Some of the managers suggested that the importance of complying with customer requirements varied depending on the contractual forms of the project and the established relationship with the client. One manager explained: "If it is a customer that is not likely to return, the importance of understanding his true needs is not so great, but if it is a returning customer it is of the utmost importance that we give him what he needs". Another manager maintained that "if it is a general contract, we are not supposed to find out if the product is in accordance with the customer's needs, we only build what the drawings say". The endeavour undertaken by their firm to identify the customer's true needs before project initiation was however clearly acknowledged

by the managers. They argued that they themselves had important roles when it came to recognising these needs when communicating directly with the customer.

Encourage further training (recommendation no. 20). The managers were generally positive about how their companies supported them with continued education. “I feel encouraged by my organisation to continue my education, they spend a lot of money sending me to courses” one manager stated. The opportunity to take part in management and leadership courses was appreciated by the majority of interviewees. “I don’t think I have ever been denied a course I have asked for” was a common comment. In some cases the managers were required to take certain courses before applying for promotion. “All managers have annual plans where it is stated which courses they are expected to take. I think we are far ahead of other companies”, a manager maintained. Some managers emphasised that it was up to them to ask for courses on new regulations and standards, as this knowledge was needed in their daily work. They argued that implementing new standards and regulations was not always perceived as a high priority for top management and argued that their superiors were not always knowledgeable about the site management role. Some interviewees commented that from time to time there was too much focus on education. They argued that their organisations had sent blue-collar employees on courses when their work was needed, thus creating on-site personnel shortages.

Seek long-term customer-supplier relationships (recommendation no. 8). All managers unanimously maintained that their organisations had clear goals regarding long-term customer relationships. It was argued that this view permeated their organisations. One manager stated that “a long-term relationship to our customers is our bread and butter, the basis of our business, the core essence of how we survive”. Interestingly all respondents perceived their organization to be superior to larger construction firms in this respect. The commonly cited reason for this was the presence of a strong owner, with long-term perspectives and using short communication routes. “The owners have established working relationships with many recurring customers”, a manager stated. He suggested that it led to continuity in operations. The managers perceived that their companies thought it was of great importance to encourage clients to return and to ensure their satisfaction so that good working relations could be maintained. “You often try to walk the extra mile for returning clients. Sometimes I think we actually help them too much”, a site manager stated. “It is of utmost importance that our returning customers are satisfied”, another manager remarked.

Lowest scoring recommendations

Use all of the week’s 168 hours (recommendation no. 9). Even though all managers maintained that their companies did not strive to increase the number of active on-site hours, the recommendation upset the interviewees. It was often misinterpreted as pushing the respondent to work more hours. It was continually necessary to explain the rationale behind it, namely that although construction involves a large investment in time and money, especially during the production stage, most construction work is carried out on weekdays between 6.45 am and 4.00 pm leaving sites empty most of the time.

Seven of the managers claimed that their firms did use the opportunity to do work on-site outside working hours. An example was to work with logistics companies that

handled material on-site after 4 pm, using trucks and elevators that were already in place. Further, one interviewee described how his current project worked double shifts in order to meet a strict completion deadline. He maintained that there were considerable difficulties involved; darkness, supplier schedules and internal communication. He stated that, “productivity is considerably lower on the late shift due to adverse conditions such as darkness and lack of backup from suppliers”.

Measure in order to uncover waste (recommendation no. 28). This recommendation roused strong debate among the interviewees. Some managers would initially not agree on that some of the consumed resources could be viewed as unnecessary. Others thought it was important to learn more about the consumption of unnecessary resources in their processes, but added that it would be difficult to introduce any measures without adding to the already heavy workload. One manager claimed that “we measure everything, but I don’t know if we use it to identify the consumption of unnecessary resources.” Another manager agreed explaining “I don’t know if the measures are used to identify excessive resource consumption, I cannot really tell”. A third manager confirmed the situation: “No, we have very much left to do with this recommendation, I don’t think I have ever come across any such measures”. Only one of the managers could give examples of how the use of unnecessary resources was measured: “In a way we do by specifying and measuring the material that is transported off site, by knowing how much gypsum and wood are removed from the site gives us some idea in the matter.” He continued “but I think we still have a long way to go, more things can be measured to bring unnecessary use of resources to the surface”. He argued that more of the everyday activities should be measured in order to reduce construction costs and increase competitiveness.

Actively support suppliers in their development (recommendation no. 16). This recommendation surprised the respondents. One manager stated that “I have never heard that my firm might support suppliers in our supply-chain, at least not in my role. I have never heard of such activities in other construction organisations either.” Another manager explained that, “in the company we don’t support suppliers. When I communicate with my suppliers, it is not to support them in their development, it is because they have done something wrong”. However, there was a trend among the contractors to attempt to reduce the number of materials suppliers. It was argued to be common practice to include an agreement in the supplier contract that the contractor will exclusively use the supplier and that, in return, the supplier will offer the best possible price. Surprisingly, the decision of whether to honour these contracts were given to the interviewees who explained that the agreements were only honoured if they were perceived as being beneficial for their specific projects or if they provided a better service than the supplier they were used to. The uniqueness of the construction industry was often cited as the reason why supporting suppliers in their development was not an option. It was also suggested that the uniqueness of each project required the establishment of a temporary organisation and the frequent use of specialised sub-contractors and suppliers. Due to the geographical dispersion of projects, the suppliers were often chosen for their proximity and their service levels. Another reason to why supporting suppliers was viewed as unnecessary was that the components used are more or less standardised. Since suppliers offer similar product characteristics and conditions, the lowest price was considered to be the most important variable. It is thus not surprising that this recommendation was perceived as having low priority.

Discussion

Based on the literature review and the findings, three discussion points have been highlighted. The first is the low priority given to reducing production time in contrast to the strong perceived emphasis on production cost. The second concerns the time-cost relationship illustrated by the apparent imbalance between the proclaimed necessity to create long-term relations with customers and the perceived unwillingness to create long-term relations with suppliers. The third relates to the perceived low priority given to gathering information and knowledge on existing unnecessary consumption of resources, and which is frequently seen to be a key issue (see Womack and Jones 2003; Liker 2004).

Low priority for reducing time. In the interviews it was apparent that financial measures were frequently seen to take the upper hand. It was argued that no questions were put to the interviewees by top management as long as the bottom line was in accordance with, or better than, expectations. It could thereby be argued that the time dimension was not given high priority by either the interviewees or by top management. Increased costs for over-time, re-work, unnecessary materials storage, and poor planning - recognized as key factors for consumption of unnecessary resources (Liker, 2004) - were often ignored (cf. Love and Edwards, 2004). A risk when over-emphasizing cost on behalf of time is that what the customer actually perceives as value are unaccounted for. Also by over-emphasizing cost, potential ideas for long-term savings were often not pursued.

Only one of the interviewees had even considered the particular problem of using only 40 or 50 of the 168 hours that make up a week. One reason for this attitude is that Swedish laws and regulations permit noisy construction activities only between 8am and 6pm. Established habits is another issue. However, even though praxis is to work 8 hours a day the managers in some projects had hired suppliers to transport materials to the right location outside normal working hours. This extended the active hours on-site. Some of the managers held that in doing so the blue-collar workers could focus on production when working. They felt this increased productivity. Others argued that carrying materials to the right place was in fact part of blue-collar work. By letting others carry out this task it was argued that the piecework salary of the blue-collar workers would become unreasonably high and thereby uneconomical for the project and unprofitable for the customers. Cost savings motivated both these arguments. Surprisingly managers from the same firm argued for these different views.

The managers did recognize the cost of time in the context of project results. Consumption of unnecessary resources was also seen to include time spent on those occasions when it was important to finish projects on time so as to avoid penalties. Even though Langford et al. (2000) suggest that improved performance has become more in focus due to client dissatisfaction, the importance of reducing costs was still often emphasised as the most important means of creating a competitive advantage. Focus was therefore mainly on reducing project costs as a way of coping with competition (cf. Faniran and Caban, 1998, Teo and Loosemore, 2001, Fearné and Fowler, 2006). The potential cost savings that might be obtained through more standardized components, better planning, or gathering and using experiences systematically has not been taken into consideration to the same extent.

Long-term relationships with customers and short-term relationships with suppliers. The second discussion point adds to the above debate and brings up the time-cost approach to customers and suppliers. The most apparent dichotomy in this affair is the perceived importance of customer-supplier relations on one hand and the unwillingness to support suppliers in their long-term collaboration on the other. It has been argued that all organizations involved in the supply chain should also be involved in improving performance (e.g. Love and Li, 2000, Dubois and Fredriksson, 2008). By simply focusing down-stream in the supply chain, key reductions in resource use may be lost (cf. Dubois and Gadde, 2000, Womack and Jones, 2003). Even though this finding is slightly myopic it is clearly in line with the arguments of Dainty and Brooke (2004) and Dubois and Gadde (2000). Contrast is supplied by Womack and Jones (2003) who identify increased collaboration through supporting suppliers in their development as a key in the reduction of resources, the managers regarded it as an unnecessary expense and in some cases even as a risk. It was argued that a dependence on specific suppliers (both material suppliers and subcontractors) would make the organization more vulnerable. The interviewees showed concern that the chosen suppliers would choose to increase their prices and become less loyal when they discover their competitive advantage. Since suppliers perform 70-80% of the work on-site in most large and medium-sized projects in Scandinavia, there seem to be opportunities for reduction of resources that have not yet been identified as unnecessary and have therefore not been exploited (cf. Borgbrant, 2003).

Realizing the potentials in developing long-term collaborations with both customers and suppliers may in fact also be a way of reducing costs by reducing the time used for negotiation. Project focus could thus be burdening for the industry. In particular for small and medium sized construction firms that are perceived to be dependent on their customer relations.

Low priority on gathering information and knowledge on the consumption of unnecessary resources. The low scores given to the recommendations related to 'lead continuous improvements' indicate that little attention had been given to gathering information about the consumption of unnecessary resources or to refining such information into knowledge. From the reasoning of Liker (2004) it follows that continuously to gathering information and knowledge are central parts in striving towards reducing unnecessary consumption of resources, improving activities or to gathering successful activities and using them systematically. Thereby, not attending to these reasons could lead to less competitiveness (cf. Flanagan et al., 2007). The answers from the interviews indicate that the firms in this regard did not explore the underlying potential for improvement to a satisfactory extent.

Systematically reducing consumption of unnecessary resources was in the interviews identified as a task for top management. This view is also supported by literature (cf. Lingard et al., 2000, Dainty and Brooke, 2004). The managers argued that their major concern was to hand over projects in time and on budget. To exceed expectations by reducing consumption of resources did not have high priority (cf. Green and May, 2005). The interviewees further maintained that as long as they achieved expected economic results top management did not ask any questions. Scrutiny only occurred if project performance was below expectations. But, by adapting a project-specific short-term approach new business opportunities that increase buildability may not materialise (Koskela and Vrijhoef, 2001, Leiringer et al., 2009). If focus is only on

underperforming projects, and aimed at identifying mistakes or errors, it could be argued that many aspects of constant improvements are lost (Liker, 2004). The information and knowledge the managers have attained through working closely in a project should therefore be recognised as of significant value for their organisations. In line with Craig and Sommerville (2006) and Dainty and Brooke (2004) more communication would be required to reform the current/existing construction culture and the willingness to gather information and knowledge on existing resource consumption.

The interviewees also argued that the many different approaches to the construction process on-site lead to that some resources were consumed only as a precaution should uncertainties appear. It was suggested that since top managements had not communicated a policy on the use of resource all site managers had created their own views (cf. Faniran and Caban, 1998). Therefore some instances of cross-level fallacy existed among individuals, groups and firms. Little consensus or few policies in how to act hinders collaborative behaviour, and could even encourage further projectification and interfere with attempts to standardize processes over project boundaries, something that has been suggested as a main hinder to attempts to reduce unnecessary resource consumption (e.g. Santos et al., 2002).

Conclusion

Compared with manufacturing industries, reducing the use of resources can be considered more challenging in the construction sector. The commercial benefits of reducing the use of resources have only recently been acknowledged. In agreement with the findings of Teo and Loosemore (2001), and Green and May (2005) a sense of inevitability towards the consumption of resources could be detected among the middle managers interviewed in this study. The respondents frequently anchored the 31 recommendations to material resources and connected them to cost aspects. This is reflected in the answers to how intensively their organisations were perceived to work with the use of resources. This focus should be put under question. The literature continuously suggests that the material resources, easily associated with cost resources, only cover a part of the wider concept of resources (cf. Womack and Jones, 2003, Liker, 2004). However, the managers in the study expressed little consensus about what the reduction of resource use could bring, as well as on the necessity to take a more holistic approach to reducing this use.

A reason given for why many of the recommendations were not perceived to be particularly important at the firms was the short-term focus on specific projects (cf. Green and May, 2005). It was argued that top management encouraged this myopic view. This short-termism may well prevent imaginative insight on the bigger picture of company success in the industry and influence the lack of urgency of reducing consumption of resources for the good of the firm (cf. Dainty and Brooke, 2004, Flanagan et al., 2007). This idea further motivates the heavy focus on cost and less focus on knowledge and time that were identified in the study. In line with Liker (2004), it could be argued that alternatives for reducing unnecessary resource consumption are lost when middle managers are encouraged to adapt to project-specific cost-centred approach.

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Paper III

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**Freedom versus standardisation in the work
role of production managers in construction**

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Freedom versus standardisation in the work role of production managers in construction

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Abstract

It is suggested that standardising construction projects improves productivity. Simultaneously, production managers are given freedom to run their projects as if they were independent firms. If this sense of freedom is what motivates managers, firms may have to find other ways to improve than to increase standardisation to be able to keep their most skilled production managers. It may prove important to recognise the managers' need for freedom before they start looking for alternative places of employment.

The purpose of this article is to inquire into how standardisation may or may not conflict with production managers' sense of freedom.

Interviews with 15 production managers indicate that standardised processes do not necessarily conflict with their sense of freedom and work motivation as long as their ability overview the production process is preserved.

This article concludes that standardisation should be developed with respect from top managers using a bottom-up approach.

Keywords: construction projects, freedom, production management, project processes, standardisation.

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Introduction

It has been claimed that implementing standards in the construction industry are confronted with many obstacles; projects of different kinds (Winch, 2002), companies with different foci (Egan, 1998), and a generally held view that every project is unique (Josephson and Saukkoriipi, 2007). It has been argued that it is up to individual companies to introduce their own standards - for e.g. materials, processes, procedures, work roles and organisational structures – in order to increase their productivity and to create competitive advantages (Gadde and Håkansson, 2001, Santos et al., 2002). A counter-argument to increased organisational standardisation is that the production managers may find motivation in their ‘freedom’ to work in an environment that is not standardised. It has been suggested that production managers in construction need freedom to navigate in their complicated realities (Djebarni, 1996, Styhre and Josephson, 2006). One could question what would happen to their sense of motivation if they were deprived of their freedom. After all, they are in charge of a multitask-organisation and they are expected to assume responsibility for construction projects of different kinds (cf. Wild, 2002, Barber et al., 1999). Their skills and abilities greatly influence the success or failure of the projects they undertake (Dainty et al., 2003). If production managers find satisfaction in their work role because of the freedom they enjoy, standardising might prove to be counterproductive.

The decision to standardise in order to increase productivity is not straightforward. If the production managers become less motivated or leave the firm due to the imposition of new standards, productivity will be affected in negative ways. For this reason standardising the managerial processes on sites faces specific challenges. Given the unique role and the considerable influence that managers have in construction projects, it may be prudent to ensure that they are involved in this discussion. It should be investigated if production managers perceive loss of freedom as a consequence of standardisation. If so, are they willing to renounce some elements of freedom without losing motivation or even starting to look for alternative employment?

The purpose of this article is to explore how standardisation influences production managers’ sense of freedom. Within the scope of the exploration are also two related research questions: 1) What aspects of freedom do production managers appreciate? and 2) How do production managers perceive standardisation? Combining the answers to these two questions opens up for a discussion on how standardisation influences production managers sense freedom.

The point of departure is the production managers’ situation at work, contrasting organisational control through standardisation on the one hand and the production managers’ need for freedom on the other. The article draws on an explorative interview study with 15 production managers in three medium-sized Swedish construction firms. Before presenting the interview study, attention is directed to the concept of freedom from a work perspective and how the production managers’ perceived need for it has been presented in the literature. Focus is then directed to literature that argues for standardisation of the production managers’ work role in order to increase productivity.

Freedom

Freedom is basically subjective, centred around the individual (Sen, 2002, Ljungqvist, 1987). The term therefore has many meanings and interpretations. Due to the subjective nature of freedom it has been maintained that individuals develop an idea of what they perceive freedom to be. Thereby sense of freedom may be more appropriate. This perception is to a great extent dependent on the individuals' background, experiences and expectations (Ljungqvist, 1987, Sandoff and Widell, 2009). From this it follows that some individuals require more freedom than others (Ljungqvist, 1987).

In the following an attempt is made to define freedom from a work perspective. The literature that concerns freedom in relation to liberty or freedom of speech will thus not be considered. To set the scene of how freedom is conceptualised throughout this article, an indulgent definition by Sandoff and Widell (2009) is given. They argue that if there is compassion for work, if pleasure is sought for in contrast to pain, and if individuals are allowed to take on responsibilities, then the individual will have a sense of freedom.

An illustration of the complexity in defining freedom from a work perspective is how individuals' perception should be viewed in relation to others when identifying freedom. Ljungqvist (1987) who maintains a psychological aspect argues that individual freedom, even from a work perspective, can be positioned on a scale between total dependence and total isolation from other individuals. Prendergast (2004), who focuses on freedom from an economist's viewpoint, argues instead that in order not to create problems when defining freedom it has to be recognized as a social commitment to adapt to the rest of society, even when focusing on an individual's perception of the term. She suggests that freedom, from a workplace perspective, has to be related to having due respect for the needs of others. Sen (2002) who, in line with Prendergast (2004) argues for the dependency of others when identifying freedom, divides freedom into opportunity freedom (to pursue what the individual value) and process freedom (to be immune from interference from others). In this article it is maintained that freedom from a work place perspective should not be viewed in isolation from other individuals in line with the reasoning of Prendergast (2004).

The level of freedom at the workplace has been suggested to affect individuals' motivation and well-being (Ljungqvist, 1987, Sandoff and Widell, 2009). An example in favour of freedom for the individual at the workplace comes from Krause (2004) where it is argued that granting autonomy to individuals is positively related to the individuals innovative behaviour. She suggests that greater autonomy supports experimentation and the implementation of new ideas, both seen to be important to middle managers in construction.

Krause (2004) and Sandoff and Widell (2009) agree that perceived freedom is an important factor for motivation and individual well-being. Sandoff and Widell (2009) take the argument further by arguing that the opposite pole to freedom and motivation is docility. Thereby they draw a more nuanced representation of individual freedom in the work role by highlighting some aspects, which are not always positive from a collaborative perspective and in relationships to others. In line with Krause (2004) they argue that individuals who feel free in their work-role are more likely to challenge established routines and to create changes that make work more effective. At the same time Sandoff and Widell (2009) point out that individuals who feel free at

work might well be more demanding to manage. They are even, in accordance to the above argument, likely to cause difficulties when trying to standardise the processes, which they are in charge of.

The qualities described above are not all beneficial for production managers who shoulder a middle managers' role. Their ability to listen carefully and to take instructions may prove to be quite as important as being innovative (Floyd and Wooldridge, 1997). Styhre (2007) also raises questions concerning middle managers' freedom. He argues that greater individual freedom and responsibility could lead to a heavy work-load and too much stress on one single individual. This in turn, he argues, leads to poor decision-making thus affecting project outcomes. Yet another aspect of production manager freedom that should be considered follows from the reasoning of Sandoff and Widell (2009) that it may lead to less freedom for top management or other employees. Their ability to take on responsibilities, to seek pleasure instead of pain and to feel compassion in their work may be lost by granting freedom to the production managers.

A review of literature that focuses foremost on freedom and factors influencing freedom among middle managers in construction reveals six factors as being important in creating a sense of freedom among middle managers.. How these factors relate to standardisation will also be discussed.

- The possibility of making decisions to deal with uncertainties on a daily basis (Mustapha and Naoum, 1998)
- The possibility to influence with whom to work by being involved in assembling the project organisation to create trustworthy teams (Khalfan et al., 2007)
- The possibility to influence how to work and to have authority to affect the project; its planning and its schedule (Styhre and Josephson, 2006)
- The possibility to manage projects as if they were independent of the organisation - uncoupling (Styhre, 2006)
- The possibility to influence at what pace to work (Simu, 2009)
- The possibility to challenge established routines and to introduce changes that make work more effective (Sandoff and Widell, 2009)

The above factors, which mostly consider the possibility to influence the task and the environment, are centred on the predicate in the sentences; make decisions, influence how to work the team and the individual role, manage project activities, challenge and change routines. These factors may form a basis for the perceived freedom among the managers. In the following section the literature that concerns standardisation in construction will be presented. The contradictions between freedom and standardisation are further observed in the discussion.

Standardisation

Standardisation of the entire, or parts of the, construction process has many proponents in the construction management literature (e.g. Edum-Fotwe et al., 2004, Gibb and Isack, 2001, Gudmundsson et al., 2004, Kondo, 2000, Santos et al., 2002). The arguments put forward in this part of the literature are often in line with production oriented literature, e.g. Womack and Jones (2003) and Liker (2004), that

present the standardisation of processes as a way to increase productivity through reduced costs and time savings. For example, Santos et al. (2002), suggest that standardisation should be viewed as a tool for reducing variability in project results by developing procedures to project processes and argue that standardisation is a way to reduce unnecessary use of resources by isolating projects processes and thus finding the best ways to carry them out, one by one. It has furthermore been suggested that the lack of standardisation in construction is one reason for the sector's low productivity and high variability, and that increasing standardisation in construction could bring about more homogeneous practices (Gibb and Isack, 2001). Urgan (2006) takes the above argument a step further and maintains that more standardisation in projects contributes to decreased uncertainty through increased consistency, coherence and efficiency. He further argues that it leads to less uncertainty for all parties in a construction project. Urgan (2006) further suggests that standardisation in construction may lead to more efficient ways of controlling processes within a project with regard to quality and safety. From this perspective he maintains that top managers should encourage production managers to change their focus from fulfilling what is specified in written documentation to carrying out of standardised practices. These implementations are considered to be achievable without individuals necessarily being forced to follow given routines (Edum-Fotwe et al., 2004).

The arguments presented above might well have persuasive appeal. Further, it is hard to refute that the adoption and adaption of standards has led to more predictable outcomes and more certain project activities (Egan, 1998). Such standards can be of the general kind applied on the national level, e.g. governmental rules and regulations that state how salary should be regulated, how many work hours that make up a week, what safety equipment has to be used to avoid accidents, or how certain contracts should be formed. These standards are complemented by standards developed by trade organisations and firms, such as safety measures more rigorous than the national standards, the adaption to ISO standards or other quality or environment agreements (Hiyassat, 2000).

Given the unique conditions of every construction site, procedural variations might have to be accepted (Koskela, 2003). But, as argued by Urgan (2006), increasing company specific standardisation of e.g. process documentation or single activities, variability and uncertainty can still be reduced. If the causes that through experience have proven to improve processes are identified and communicated, then better routines that lead to more consistent operations can be established (Edum-Fotwe et al., 2004, Chen and Partington, 2006). Styhre (2007) argues that such changes in projects may lead on to decreased stress and more satisfactory work-burdens for production managers.

It is, nonetheless, important not to neglect the literature that criticises increased standardisation. A common view among researchers is that standardisation could stand in the way of innovative behaviour (Kondo, 2000, Gudmundsson et al., 2004). Considering top managers' evaluation base, standardisation might in fact prevent effective fire fighting (Styhre, 2007). Also, standardisation has been suggested to stand in conflict with production managers' motivation (cf. Mustapha and Naoum, 1998).

Based on the above argumentation the undertaken definition of standardisation in this article will be the structured planning and execution of activities that experience has

shown to be effective. This view of standardisation is used since it applies in an overall but also in a local perspective.

Method

The purpose of this article is to explore how standardisation influences production managers' freedom. Its point of departure is the production managers' situation at work, contrasting organisational control through standardisation on the one hand and the production managers' need for freedom on the other. After an initial literature review, where aspects of freedom and standardisation was brought up 15 production managers (twelve site managers, two project managers and one manager of improvement activities with focus on site management activities) in three Swedish construction firms was interviewed. The companies were chosen based on their location and on their willingness to participate in the study. All interviews took place in the vicinity of Gothenburg.

The interviews were explorative and semi-structured with a phenomenographic approach in accordance with Chen and Partington (2006) and Åkerlind (2005). Inspiration was also drawn from Brunåker and Kurvinen (2006) who used this method for collecting data in a similar study. The interviews were 100 to 130 minutes in length. To acquire a better understanding of the concepts freedom and standardisation, an open-ended approach with follow-up questions was preferred. The interviewers avoided using the words 'standardisation' and 'freedom' in order to avoid biased answers. The goal of the interviews was to identify descriptive categories that differentiate between the stated views presented in the literature.

Three researchers were present at the first two interviews. During the subsequent interviews two researchers were present at nine and one at four. One researcher conducted the interview. The other researchers filled in with follow-up questions. The interviews were recorded and notes were taken during and after the interviews. After the interviews, observations and reflections were discussed. The interviews were transcribed verbatim. Analysis was performed using an interpretative non-hypothetical approach emphasising the respondents' perceived understanding of the concepts in question (Bryman, 2008). Both qualitative and quantitative data were extracted from the transcriptions. This approach was used since individuals' views and the interpretation of social processes were of interest (Silverman, 2000).

Findings

The following sections present key distinctions concerning how production managers perceive freedom and standardisation as well as how they perceive standardisation influences their work role

Production manager's relationship to freedom

The dominant views among the interviewees were that freedom connected to their possibility to influence the production process because it allowed them to solve tasks and deal with uncertainties following their own judgement. Some examples are; "*You get a task and you are given the freedom you need to solve it*", "*You don't have to ask others how to do your work*", "*You have freedom and you are expected to do it in your own way*", and "*You have a goal and I feel that you have the freedom to solve the tasks required in order to reach it*". These statements show the manager's perceived importance of solving construction projects as they see fit. However, the managers continually maintained that their ability to influence single activities that

make up the projects was not primarily what was sought. Instead, their ability to influence the construction process to increase controllability so that uncertainties could be acted upon was argued to be important in giving a sense of freedom. Another common statement along the same line of argument was drawn from a more extensive process picture: *“freedom is to be able to assemble a team so that you can work with people you know and rely on”*. Freedom was thereby also linked to the ability to influence project team composition. The freedom to influence and overview the production process was frequently argued to be a key to motivation in the manager role.

Allowance for individual differences were identified as a freedom factor and as a key to motivation for working as a production manager. A root cause for the perceived importance of encouraging individual differences was felt to be the uniqueness of the projects. *“We all have various experiences and therefore we have different qualities, applicable on different projects”*. The uniqueness of the projects was from this aspect also identified as a freedom factor. It was argued that since every project is unique the managers are continuously challenged by new circumstances and thereby continuously have to put their experiences to the test. This makes their combination of experiences unique. The above argument indicates that the managers’ ability to act in accordance with their own previous experiences is important for production managers to feel challenged and thereby free.

Apart from the freedom they enjoyed through trust of their superiors, the interviewees described freedom in many different ways. It was argued that freedom in the form of trust also brought about increased responsibilities, which were thought to lead to more burdening work roles. Some of the managers identified this as a factor increasing stress, as projects grew bigger and more complex. It was argued that increased stress decreased their feeling of freedom since they were not at liberty to focus on their own tasks, but instead had to control the performance of other players. The interviewees thereby argued that given constraints in their work could in fact be viewed as freedom factors. By being set boundaries and limits, the managers’ field of responsibility was perceived to some extent decreased, which made them feel they were more in command of their own activities. The managers gave examples of positive constraints both in regard to time and to money. They argued that some constraints were necessary to define the outer boundaries of their projects. From this perspective responsibility without constraints and support from top management were seen to limit freedom. It was argued that both the trust and commitment of superiors were becoming more important as project size and complexity grew letting other types of freedom surface. An example is provided by the following statement *“I don’t have to show anyone that my project is on time and on budget or that I have been working eight hours every day. Everyone trusts me on these”* a manager claimed. After thinking a while he continued *“but I know that I have my boss in the background. If I feel stressed or if I don’t have control, I know that he is there and that he will support me if I need him to”*. The view that emerged from these opinions was that freedom was connected to both to top management allowing space for the individual to set up his own projects and work days and not to feel controlled by top management, but simultaneously that the individual experienced the back-up of superiors as positive in those something unexpected happened.

Production managers' views on standardisation

The interviewees suggested that standardisation is difficult to implement in construction. Standards were often viewed as threatening to their work role. The perceived uniqueness of every project was identified as the key argument against increased standardisation. As an example, an interviewee stated "*everyone must solve their task in their own ways, since every project is unique. You have to adapt to your surroundings*". It was argued that projects had to be planned, organised and run in different ways since the work site, the building, the customer and the subcontractors always differed, and this was argued to create unique conditions for each project. Consequently, the interviewees also emphasised that there were many different ways of working to reach the goal. It was therefore suggested that every project should be considered as a unique effort in its execution. Standards established to control the execution of the whole project were thus argued to be unbeneficial and by some of the managers even counterproductive.

However, some established routines, especially ones regarding rules and regulations, environment, and safety, were given as examples of existing, already well implemented standards. It was suggested that the configuration of the work site, e.g. how accommodations are set up, what tools and equipment are to be rented and the formal procedures, such as paperwork, that have to be implemented at projects had also been standardised to some extent.

Even though the interviewees regarded these activities as means of encouraging them to work in more similar ways, they were not perceived as threats to freedom. Instead, it was argued that such standards provided them with a more structured frame to work within. The standards were not, as has been suggested, viewed as means of increasing the efficiency of their operation, but rather to simplify their work task and to make the site look better for the clients and the general public. From this aspect, standards were seen as beneficial for production managers.

Another example of increased standardisation in projects that was viewed as beneficial was that the number of products used in buildings had been reduced considerably. One of the interviewees stated that the types of inner walls in one of his projects had been reduced from eight to three. He stated "*I get an architect's drawing with a list of wall types.... Then, I arrange them into as few groups as possible. Everyone benefits from this. It is less messy and I get more time to do my thing.*" The same production manager claimed that even if some of the walls got a little extra soundproofing, which implies more expense, the risk of human error is reduced. He continued: "*To set out the different walls is one thing, but we are only human. When working on site with music on, the risk for error is much smaller when there are fewer alternatives to chose from*". This statement may be understood as an attempt to standardise and to decrease variability in choice of materials but it was also a means of simplifying the building process strengthening his control over the project.

Further initiatives to standardise activities were identified. The arrangement of materials storage on site, the detailing of the stages at which papers need to be signed and a specifying where they should be sent, standardising meetings, how and when to announce them, how to conduct them and how to report from them were some of the initiatives. However, the production managers regarded none of these suggestions as examples of standardisation. One of the managers argued "*if you can get individuals to work more alike, more time could be devoted to my work, planning and economy*".

An interesting aspect of the suggested standards was that they were seen to increase time available for the managers to do their work on their own terms.

Even though this categorisation points to some positive aspects of standardisation, the respondents who used the term “standardisation” were often circumspect about using it. This suggests that the term had not been generally well received by the managers.

Freedom in relation to standardisation

The interviews showed that the standards, strategies and goals that had been established by top management were understood in different ways. Some of the interviewees regarded them as voluntary guidelines, others regarded them as instructions to be followed strictly. Some of the managers viewed them as ways for top management to gain control. Others argued that it was a way to reduce their own responsibility. These different views triggered off various discussions around the concepts of freedom and standardisation. An example was given by one of the interviewees “*there is an operating procedure in the organisation about how to write protocols from construction-meetings so that the information looks the same each time*”. Such protocols were argued to be important for top management so that they could follow-up projects or verify how certain decisions had been made. But, even if such standards existed, they were claimed to look quite different from one meeting to another, depending on who wrote them. Even though the procedure of writing them had been clearly described “*in one project they can be neatly structured, with fields of responsibilities and dates when certain tasks should have been solved are clearly defined, in other projects, they are written by hand*”. This was argued to be due to some managers feeling restricted when filling in operational procedures in accordance with a standard, others viewed it as a means of transferring risks to top management.

Another discussion that describes the relation between freedom and standardisation concerns respecting supplier agreements. Some of the managers had chosen not to honour such agreements. They considered it convenient to use local suppliers, who gave them better service or a supplier they had relied on before and therefore trusted. One of the respondents declared how surprised he was when he came to his current site with the ambition to follow the guidelines. He was bluntly told that no one ever followed the guidelines given by top management. “*The only people who comply with the new agreement are those who have relied on the same supplier prior to the agreement*” he stated. He then argued that this should be an issue for the top managers to respond to. “*In my opinion, the managers are far too lax. They give up on their policies too easily. They should stick to their position in order to win our respect*” he concluded. This implies that there are some tensions in the relationship between top managers and production managers.

Some of the respondents commented on the consequences of disregarding given guidelines. Trust from suppliers was a major concern for the interviewees: “*Not to honour agreements we have made will certainly strike back on us when we finally decide to comply. By then, the suppliers will not extend any benefits at all, since they have learned that we do not follow the agreements that have been set up*” one of the interviewees argued.

Discussion

Quite a few studies focusing on the need for standardisation in construction have been identified (cf. Santos et al., 2002, Edum-Fotwe et al., 2004, Josephson and Saukkoriipi, 2005). Considerably fewer studies that focus on the production

managers' need for freedom in their work have been found (Styhre and Josephson, 2006, Djebarni, 1996). This article attempts to explore the interrelation between the two terms from a production managerial perspective. In the following, production managers' opinions on freedom and standardisation are discussed one at a time as they related to the research questions of the study, in the subsequent they are discussed together.

Aspects of freedom appreciated by production managers

The interviewed production managers described their needs of freedom in their work role. Their arguments were in line with established assumptions in the literature. Both project uniqueness and uncertainties were identified as reasons for why freedom was perceived to be essential in their work. The interviewees expressed being able to draw on their previous experiences, to control their workday and have the possibility to influence and overview projects as central for their sense freedom, agrees well with the literature. The idea that too much responsibility led to less freedom was less in line with previously published reports. Being given too much responsibility can be justified as a constraint to the importance of giving the managers freedom to binding up their workday, which in literature is interpreted as less motivating for the managers (Sandoff and Widell, 2009). Instead, it was argued that entrusting production managers with too much responsibility but giving them little support instead constrained them in their work, providing them with an environment that offered little sense freedom. The interviewees complained that too much responsibility compelled them to execute routine site related tasks at given times allowing them no liberty to deal with what they perceived to be the most urgent issues.

By analysing the interviews with regard to the six factors that were identified in the literature some corresponding connections were found. The three freedom factors suggested by 1) Simu (2009); The possibility to influence at what pace to work, both regarding stress-level and uncertainty; 2) Khalfan et al. (2007); The possibility to influence with whom to work by being involved in assembling the project organisation to create trustworthy teams, and 3) Styhre and Josephson (2006); The possibility to influence how to work and to have authority to influence the project, its planning and its schedule, seem to be the most important factors perceived by the managers. While the interviewees talked about their dependence on trust from top managers within certain given frames of responsibilities, the other suggested factors were not seen as important for the managers' sense of freedom. The factor argued for by Sandoff and Widell (2009) - the possibility to challenge established routines and to introduce changes that make work more effective - may in this context be connected to the managers' desire to be given space for individual differences. Simultaneously the managers in the study claimed they needed some established routines in the activities that make up the projects. Therefore it is doubtful whether this recommendation would be useful.

How production managers perceive standardisation

When the interview focus was shifted to standardisation it became clear that the term was perceived in a way that differed from the literature. The interviewees were circumspect about standardisation as a concept. The term often had negative connotations: standardisation was associated with limiting and controlling their work. It was seen to diminish their ability to influence their projects, thus limiting their freedom to react to uncertainties and problems that surfaced (Koskela, 2003, Kondo, 2000). But in contrast to what is described in the literature, some of the standards that

were in use were not viewed in this manner. Often these were not even recognised as standards. To limit the number of inner walls, to standardise documentation meeting structures or on-site clothing was commonly seen as ways of simplifying the managers' work, safeguards to avoid errors, or safety measures to avoid injuries.

Even though the managers were circumspect about using the term standardisation, a willingness to implement more standardised processes in their projects was detected. It was argued that by doing so they would be able to focus on more important issues, - creating more perceived freedom. The activities that were seen as not being unique could be standardised without influencing the production managers' freedom (cf. Edum-Fotwe et al., 2004). As long as the managers were able to influence how to plan these activities, they deemed that standardisation would not significantly affect their freedom or motivation. Instead, their ability to influence the project production phase was viewed as important (cf. Styhre and Josephson, 2006). From this perspective it can be maintained that the managers overview-ability should be left untouched. Since the mix of activities gave rise to the project uniqueness, every project had to be managed differently. This line of argument revealed the same need for individual differences that had also been identified when discussing freedom.

In line with Sandoff and Widell (2009) the interviewees held that standardising their work processes would make them less motivated in their work role and thus more docile. Therefore, it could be argued that if the implementation of standards makes the production managers feel they are entrusted with less responsibility and thus have less freedom to choose which methods to use in their projects - seen as the main factor in their sense of freedom, increased standardisation could have negative effects.

How standardisation influences production managers' freedom

An examination of the managers' views on standardisation and freedom makes it clear that their main concern was not to necessarily avoid standardised solutions or to maintain high levels of freedom. Instead, the managers related freedom to their ability to influence and overview the production process. It was frequently stated that standards that decreased uncertainty and variability were not perceived to reduce freedom as long as they were absorbed into their project organisation and accepted by sub-contractors.

It was argued that the standardisation of e.g. materials, specific activities, regulations or safety measures could increase the time the managers can devote to more important work, and the opportunity to achieve things in which the managers found value (cf. Sen, 2002).

For perceiving freedom the managers instead argued for their ability to survey the projects financial development, influence the project team, update its schedule or inform the client on the project process (cf. Styhre and Josephson, 2006, Khalfan et al., 2007, Simu, 2009). The managers made it clear they wanted to be entrusted with "process freedom" to make autonomous choices and to be kept free of outside interference. This is well in line with what is reported by (Sen, 2002). The managers desired to act within given frames established by top management. Instead of avoiding standardisations their main concern was being able to influence the standards that were worked out (cf. Sandoff and Widell, 2009). It was argued that such standards had to be built on previous experiences. Not necessarily the managers' own explicit experiences but the experiences of other managers in similar roles that

had proven to be effective, –much in line with the definition of standardisation utilised in this article.

In extension to the above argument, some of the interviewees indicated that many formal activities took significant amounts of time away from more important work (cf. Faniran and Caban, 1998). The managers argued that many such activities, e.g. formal paperwork, could be standardised and performed by supporting staff. Instead of reducing their control the managers argued that it would give them the opportunity to maintain a better overview of the project, and allow them more time to spend on-site. It could thus be argued that letting others take over the formal parts of the production managers' work would lead to increased freedom. As indicated in the findings, some of the managers made the case that many standards created a better frame to work in and thereby led to a more certain work role. A framework that limited some aspects of their work roles could be seen as increasing their sense of freedom. This has not been described in the literature. Some managers even argued that a structured work role would in fact increase their motivation and provide them with more influence over the projects. The findings thereby indicate that production managers prefer a feeling of being in charge of the set-up of construction process, and to have an overview and a sense of control of their projects rather than having total freedom to run projects as they see fit within vaguely defined work roles (cf. Koskela, 2003).

Conclusions

Freedom is subjective, while standardisation is more objective. Individuals have their own perception of freedom; standardisation is more uniform. The interviewees in the study focused especially on three factors that affect perceived freedom in their work roles: the possibility to influence with whom to work by being involved in assembling the project organisation to create trustworthy teams; the possibility to influence how to work and to have authority to influence the project process, its planning and its schedule; the possibility to influence at what pace to work both regarding stress-level and uncertainty. The question of how these factors are affected by standardisation is in accordance with the findings dependent on how they interfere with production managers' ability to overview and influences their projects.

An explanation for the dissimilarity between how the phenomena are experienced is due to differences in how standardisation is understood. In this article, the definition of standardisation is more comprehensive than what the term is for the interviewees. They had a narrower view, tied to their ability to influence projects. In contrast with what was expected, some suggested standards were claimed to free time thereby increasing freedom and motivation. However, the respondents did often not think of these as standards maintaining that they did not significantly affected their work. This indicates that the production managers' perceive the concept standardisation as hazy, whilst they feel the actual application of standards to be quite straightforward. It seems as if the managers associated increased standardisation with reduced freedom. But the findings show that creating more standardised work roles with clearly established lines of responsibility for planning, scheduling and selection of the project team, production managers often feel they have more freedom to achieve the things they value (cf. Sen, 2002, Prendergast, 2004). Standardisation can thus provide perceived freedom.

The study shows that production managers in medium-sized construction companies are not averse to standardisation. As long as the standards are firmly and respectfully implemented, based on experience and do not affect the managers ability to influence the production process, standards may even be perceived to generate greater freedom for production managers. Consequently, in order to deal with the challenges that are raised by the need for standardisation and the production managers' need for freedom, further standardisation of projects and project activities may be developed with respect and using an unhurried bottom-up approach.

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