Implementing Performance Measurement to support Continuous Improvement

An empirical case study in construction industry

Nicolas Minier

Supervisor: Promporn Wangwacharakul
Examiner: Martina Berglund

Institute of Technology, Linköping University, Sweden
September 2014

LIU-IEI-A—14/02077—SE
Copyright

The publishers will keep this document online on the Internet – or its possible replacement – for a period of 25 years starting from the date of publication barring exceptional circumstances.

The online availability of the document implies permanent permission for anyone to read, to download, or to print out single copies for his/hers own use and to use it unchanged for non-commercial research and educational purpose. Subsequent transfers of copyright cannot revoke this permission. All other uses of the document are conditional upon the consent of the copyright owner. The publisher has taken technical and administrative measures to assure authenticity, security and accessibility.

According to intellectual property law the author has the right to be mentioned when his/her work is accessed as described above and to be protected against infringement.

For additional information about the Linköping University Electronic Press and its procedures for publication and for assurance of document integrity, please refer to its www home page: http://www.ep.liu.se/.

© Nicolas Minier
Abstract

Performance Measurement is necessary in order to support the implementation of a Continuous Improvement approach within a company. Performance Measurement has been a subject of increasing interest for researchers and practitioners. The questions addressed in the literature especially evolved from “what” to measure to “how” to measure. The present thesis follows this evolution by exploring how companies can successfully implement Performance Measurement.

The thesis follows a parallel research design including a literature review and a case study. From one side, a literature review aims at explaining the main theories behind Performance Measurement, such as the concept of Performance Measurement System, as well as giving some recommendation for its implementation. On the other side, an empirical case study, conducted in a construction industry company, presents a practical implementation of Performance Measurement including some of the indicators dashboards built in several factories and departments of the company. The results of this case study are also supported by several interviews conducted at different steps of the implementation with the different actors involved. Then a theoretical verification is conducted by comparing the theory from the literature review with the empirical results from the case study. It especially allows to verify some recommendations as well as to identify a few gaps.

The results of this study can be seen as a set of verified recommendations in order to successfully implement Performance Measurement within a company. These recommendations come from the comparison between theory and practice and they are divided in three main parts: the Key Performance Indicators identification, the Performance Measurement System design, and the practical implementation of Performance Measurement. Regarding this last part, five key success factors (e.g. perceived benefits of performance measurement, top management commitment) and five barriers (e.g. time and effort required, human behaviour) have been verified.

Moreover, some Performance Measurement issues are discussed, such as the reduction of the complexity, the potential gaps between local approaches and global consistency, as well as the concept of organisational learning. Finally, the thesis identifies three kinds of trade-offs (e.g. accuracy of the data and cost of collection) that need to be considered when implementing Performance Measurement.

Key words:

Key Performance Indicators, Leading measures, Performance Measurement System, Balanced Scorecard, Monitoring room, Dashboard, Organisational learning, Double-loop learning
Acknowledgement

I would like to thank my academic supervisor Promporn Wangwacharakul for her effective guidance throughout the whole project. Her active support has been very useful during all the steps of the thesis writing.

I would also like to thank my examiner Martina Berglund for her attentive review of my thesis. Her comments also led to significantly improve the quality of this report.

Then, I would also like to thank my opponent Alexis Messier for his interesting comments. They led to a deeper reflection regarding the work I have done.

Even though the company of the case study is anonymised in this thesis for confidentiality issues, I would like to thank all the people I met within the company during the implementation of the Performance Measurement approach, especially my manager who gave me valuable advices.

Finally, I would like to thank all the people I met from the administration of Linköping University, who helped me regarding the double-degree agreement process between Linköping University and my home engineering school (Grenoble Institute of Technology).

Linköping, September 2014.

Nicolas Minier
## Contents

1. **Introduction** ............................................................................................................. 1  
   1.1. Problem background ......................................................................................... 1  
   1.2. Purpose and research question ........................................................................... 3  
   1.3. Scope of the study ............................................................................................. 4  
   1.4. Outline of the thesis .......................................................................................... 4  

2. **Methodology** ........................................................................................................... 6  
   2.1. Overall research design ...................................................................................... 6  
   2.2. Methodology for the literature review ............................................................... 6  
   2.3. Methodology for the empirical case study ......................................................... 7  
   2.4. Methodology for the theoretical verification ...................................................... 10  
   2.5. Method limitations ............................................................................................ 10  

3. **Literature review** ...................................................................................................... 12  
   3.1. The concern for Performance Measurement ..................................................... 12  
   3.2. The evolution of Performance Measurement ..................................................... 14  
   3.3. The Performance Measurement System ............................................................ 15  
   3.4. The implementation of Performance Measurement Systems ............................ 18  
   3.4.1. Key success factors for implementation ....................................................... 18  
   3.4.2. Barriers for implementation ......................................................................... 21  
   3.5. Managing change in Performance Measurement ............................................. 23  
   3.6. Performance Measurement issues ...................................................................... 24  
   3.6.1 Different kinds of measures ............................................................................ 24  
   3.6.2 Reduction of the complexity ......................................................................... 24  
   3.6.3 Local approaches and global consistency ....................................................... 25  
   3.6.4 Organisational learning ............................................................................... 25  
   3.7 Performance measurement in construction industry ........................................ 26  

4. **Empirical case study** ............................................................................................. 29  
   4.1. Context of the case study ................................................................................. 29  
   4.2. A practical implementation of Performance Measurement ............................... 31  
   4.2.1. The overall design of the PMS .................................................................... 31  
   4.2.2. Preliminary questions for Performance Measurement implementation .......... 33  
   4.2.3. The global construction principle of the dashboards .................................... 34  
   4.2.4. The dashboards of the factories “Medium Rooms” ..................................... 37  
   4.2.5. The dashboards of the construction sites “Medium Rooms” ..................... 39  
   4.2.6. The dashboard of the “Big Room” ................................................................ 40
4.3. Facilitators for the implementation ................................................................. 41
  4.3.1. Committed managers ................................................................. 41
  4.3.2. Involved employees ................................................................. 42
  4.3.3. Structure of the PMS ................................................................. 42
4.4. Difficulties encountered during the implementation ........................................... 43
  4.4.1. Time and effort required ............................................................. 43
  4.4.2. Finding appropriate measures ........................................................ 43
  4.4.3. Analysis phases in general ............................................................ 45
  4.4.4. The reluctance for measurement ...................................................... 46

5. Analysis ............................................................................................................. 47
  5.1. KPI identification .......................................................................................... 47
  5.2. PMS design .................................................................................................. 51
  5.3. PMS implementation .................................................................................... 55
    5.3.1. Key success factors .............................................................................. 55
    5.3.2. Barriers ............................................................................................... 59
    5.3.3. Performance Measurement issues ...................................................... 62

6. Discussion ......................................................................................................... 65
  6.1. KPI identification .......................................................................................... 65
  6.2. PMS design .................................................................................................. 65
  6.3. PMS practical implementation ...................................................................... 66
  6.4. Performance measurement trade-offs ......................................................... 67
  6.5. Methodology reflection .................................................................................. 68

7. Conclusion ......................................................................................................... 69

8. References ........................................................................................................ 71
List of Figures

Figure 1: Deming’s PDCA cycle (Bititici and Nudurupati, 2002) ........................................ 1
Figure 2: Model of a quality management system based on the process approach (ISO
9000:2005) ......................................................................................................................... 2
Figure 3: Research design ..................................................................................................... 6
Figure 4: Two kinds of formal interviews conducted at ABC ................................................ 9
Figure 5: Phases in developing a PMS (Bourne et al., 2000) .............................................. 16
Figure 6: Organisational process to review PMS (Sallum and Myrelid, 2012) ..................... 23
Figure 7: The different axes of the ABC CI approach (ABC) ............................................. 30
Figure 8: Overall design of the ABC PMS (ABC) ............................................................... 32
Figure 9: Standard construction process of the dashboards ............................................... 34
Figure 10: Matrix of the implemented dashboards .............................................................. 35
Figure 11: Focus of the monitoring rooms regarding a construction process .................... 37
Figure 12: One ABC factory Medium Room’s dashboard .................................................. 37
Figure 13: Quality indicator of one construction site Medium Room’s dashboard ............. 39
Figure 14: Measure of the Quality regarding a construction process ................................ 50
Figure 15: Comparison of Bourne et al. (2000) PMS development framework with the
implemented PM approach ................................................................................................. 52
Figure 16: ABC PM approach displaying the two different PM cycles ............................... 54
Figure 17: “Improved” ABC PMS displaying the two different PM cycles ......................... 54
Figure 18: Dilbert and the management commitment in PM (Adams, S., 2006) ............... 56
Figure 19: Dilbert and the human behaviour with PM (Adams, S., 2002) ......................... 60
Figure 20: Support linkages between PM and OL ............................................................. 64

List of Tables

Table 1: Requirements interviews ....................................................................................... 9
Table 2: Feedbacks interviews ............................................................................................. 9
Table 3: Main topics of the unstructured interviews ........................................................... 10
Table 4: Why companies engage in performance measurement (Neely, 1998) .................. 13
Table 5: The four perspectives of the BSC (Kaplan and Norton, 1992) ............................. 15
Table 6: Requirements for developing a PMS process (Hudson et al., 2001; Platts, 1994)
................................................................................................................ 17
Table 7: Key success factors for PMS implementation ....................................................... 20
Table 8: Barriers for PMS implementation ......................................................................... 22
Table 9: Quantitative KPI in construction industry (Cox et al., 2003) ............................... 27
Table 10: Qualitative KPI in construction industry (Cox et al., 2003) ............................... 27
Table 11: Intuitive Pareto and 5M in Safety analysis .......................................................... 36
Table 12: KPIs of the factories Medium Rooms’ dashboard ........................................... 38
Table 13: KPIs of the construction sites Medium Rooms’ dashboard ................................ 40
Table 14: KPIs of the Big Room’s dashboard ..................................................................... 41
Table 15: KPIs of all the monitoring rooms discussed in the case study ............................ 47
Table 16: Use of the literature’s construction KPIs in the case study ................................ 48
Table 17: Discussion of the ABC’s performance areas in the literature ......................... 49
Table 18: Comparison between AFNOR recommendations and Bourne et al. (2000)
framework regarding review loops in PM ....................................................................... 53
Table 19: Verification of key success factors ..................................................................... 59
Table 20: Verification of barriers ....................................................................................... 62
List of abbreviations

AFNOR: Association Française de Normalisation (French organization for normalization)
BSC: Balanced Scorecard
CBPP: Construction Best Practice Programme
CI: Continuous Improvement
EFQM: European Foundation for Quality Management
IMM: Industrialization, Methods and Maintenance
ISO: International Organization for Normalization
MD: Man-day
MH: Man-hour
KPI: Key Performance Indicator
KPO: Key Performance Outcome
OL: Organisational Learning
PM: Performance Measurement
PMS: Performance Measurement System
PPE: Personal Protective Equipment
1. Introduction

This first chapter aims at giving an understanding of the problem background for the thesis. It also sets the purpose of the study as well as the research question. Then, the scope and the outline of the thesis are presented.

"- I think we improved compared to last year... - You must be right, I have the same feeling."

1.1. Problem background

In many organisations, Continuous Improvement (CI) has become a buzzword (Bititici and Nudurupati, 2002). But what is CI? There are in fact several definitions. Deming (1986) defined CI as a philosophy. According to Juergensen (2000), CI consists of improvement initiatives that allow increasing successes and reducing failures. Bessant et al. (1994) described CI as a process focused on incremental innovation. Considering CI as a philosophy, an initiative or a process, it is based on “CI methodologies” (Bhuiyan and Baghel, 2005) such as the Lean Manufacturing or the Six Sigma that offer a large range of tools aiming at increasing performance in a continuous and sustainable way. There are also different objectives for CI regarding the people involved. These different objectives are: to improve financial results for the investors, to improve business results for the senior management, to improve processes for the middle management, and to improve activities for the operational staff (Bititici and Nudurupati, 2002). Regarding these various CI definitions and objectives, Deming (1986) proposed that performance could be measured and analysed through a standard closed-loop approach called the PDCA cycle. This method, describing in Figure 1, is composed of four steps (Plan, Do, Check, Act), each of the steps leading the other aiming at settling a virtuous circle.

![Figure 1: Deming’s PDCA cycle (Bititici and Nudurupati, 2002)](image-url)
Figure 1 shows how performance measurement can be seen as a key driver of CI. Indeed, performance measurement, which is focused on data, constitutes an important component of CI since it particularly allows companies to assess their improvement and to see where they are and what they have to improve (Neely, 1998).

Kossof (1993) suggested another definition for CI, as a means in order to achieve total quality. This definition is closer to the ISO standard definition of Continual Improvement. The ISO standard uses the term of Continual Improvement in which “continual” properly means “continue in discrete jumps” and which is considered to be more “correct” when dealing with improvement processes within companies. However, the literature mostly use the term of Continuous Improvement. Therefore, there has been no distinction in this thesis and only the term of Continuous Improvement has been used in the following parts. CI is the 6th of the 8 principles of the quality management, from the ISO 9000 standard. According to the ISO 9000 glossary, the definition of Continual Improvement is a “recurring activity aiming at enhancing ability to meet requirements”. Figure 2 below, from the ISO 9000, illustrates the quality management system within the main company process.

![Figure 2: Model of a quality management system based on the process approach (ISO 9000:2005)]
At the bottom of the graph in Figure 2 is drawn the main process of a company, which consists in the product realization, from customer requirements to a final objective: customer satisfaction. This graph shows that quality management, first and foremost, comes from the management responsibility as well as from the involvement of all the employees of the company. Thereafter, the CI of the quality management system includes the key stages of **Measurement**, **Analyse** and **Improvement**. The thesis especially shows how these three key stages can drive a Performance Measurement approach.

As previously stated, both literature and standard show that performance measurement is necessary in order to support CI. This justifies the implementation of performance measurement within organisations that want to adopt a CI approach. In addition to scientific literature and standard, the need of performance measurement in order to support CI is also expressed by some governmental organisations. For example in the United Kingdom, the RSA (Royal Society for the encouragement of Arts, Manufactures and Commerce) suggested in 1994 that a company should set relevant performance measures in order to support its sustainable success in the marketplace.

### 1.2. Purpose and research question

During the 80s and 90s, in order to support the CI literature, the studies in the field of performance measurement were more oriented to the question of “what” to measure. The measures especially evolved from a financial focus to a more balanced view, thanks for example to the Balanced Scorecard (BSC) developed by Kaplan and Norton. Thereafter, some authors (e.g. Bourne et al., 2000) argued that the existing studies were not sufficient for the practitioners since there were a lack to answer the question of “how” to implement performance measurement. Therefore, there has been a growing literature about the implementation of performance measurement (e.g. Bourne et al., 2000; Bourne et al., 2002; Hudson et al., 2001). This literature especially addressed the difficulties of performance measurement implementation and it was particularly claimed that 70 per-cent of performance measurement initiatives failed (McCunn, 1998). Regarding this high rate of failure, the purpose of the present thesis is to give some answers to the following question:

**How to successfully implement performance measurement within a company?**

The word “implement” in the above question contains all the phases from choosing the measures until their use in the organisation. Bourne et al. (2000) defined four main phases in the implementation of performance measurement: the design of the measures, the data collection, the use of the measures, and the review of the measures. These four phases belong to the word “implementation” in this thesis. The word “success” is defined in the same way as in the article of Bourne et al. (2002, p. 1292), i.e.: “when management teams use the majority of the measures in the management of their business”.
1.3. Scope of the study

As stated in the research question, the present thesis deals with the implementation of performance measurement within a company. It is based on a comparison between theoretical recommendations and empirical results from a practical performance measurement implementation within a construction company. The thesis aims at giving some recommendations regarding the different steps of implementation: the choice of the indicators, the framework for performance measurement, and the practical issues of implementation. It especially aims at verifying key success factors and barriers for performance measurement implementation. It is important to state that this thesis only covers the implementation phase. It means that only the “first uses” of the measures are discussed and that the issues regarding the long-term uses of the measures are not included in the present thesis. Moreover, as stated in the problem background, performance measurement is a key driver for CI. Similarly, regarding the case study of this thesis, performance measurement has been seen has a centre tool for CI implementation. Therefore, this thesis is focused on performance measurement implementation for companies which want to support their continuous improvement approach. Indeed, as illustrated with the cycle design in Figure 1, the concept of performance measurement described in this present thesis can only be considered with a strong link with continuous improvement.

The empirical case study of the thesis is based on a practical engineer internship conducted in a French company of 1300 employees (called ABC due to confidentiality issues), specialized in the industrialized modular construction. The literature of performance measurement especially distinguishes the construction industry form the manufacturing industry in general. Performance measurement first appeared in the manufacturing industry. Later, in the mid-1990s, it has been applied to construction industry and it will be further shown in the thesis that some authors (e.g. Beatham, 2004) described for example the limits for its application in construction industry. For the case study of the present thesis, it can be considered that ABC belongs both to the construction and manufacturing industry, since the process of modular construction consists in manufacturing the buildings at 80-90% within a factory.

1.4. Outline of the thesis

After an explanation of the research design, the methodology used for the study and the identification of its limitations, a literature review of performance measurement is conducted. This literature review presents the concern and evolution of performance measurement and the concept of the performance measurement system. Then, it gives some recommendations for the implementation and also raises some issues. Then, an empirical case study is described, dealing with the implementation of performance measurement in one company. Thereafter, an analysis part aims at verifying the performance measurement theory by comparing the literature review with the results of the empirical case study. Afterwards, the
main outcomes of the analysis are discussed regarding the different similarities and gaps identified between theory and practice. Finally, a conclusion ends the report by giving answers to the research question.
2. Methodology

After a presentation of the overall research design, this chapter provides an understanding of how the research has been carried out following the different research phases: the literature review, the empirical case study and the theoretical verification. It also explains the limitations of the chosen research method.

2.1. Overall research design

As showed in Figure 3, after the definition of the research question, the research has been conducted through two parallel processes. One “theoretical” process consisting in the literature review, and one “practical” process consisting in a case study dealing with the implementation of performance measurement in one company. This research design allowed comparing theory and practice of performance measurement implementation.

Considering the research design, it could have been also interesting to conduct the literature review before the empirical case study instead of conducting both in parallel. Indeed, it could have allowed to apply some theoretical recommendations to the case study. Nevertheless, the context of the case study made the linear design difficult, and as a result, this presented parallel design allowed to conduct a theoretical verification. Moreover, this parallel design allowed keeping the focus on “how” to successfully implement performance measurement. It aimed at validating important theories of the literature, as well as underlining some gaps considering the particularities of the case study, which would have been more difficult to conduct with a linear design.

2.2. Methodology for the literature review

The literature review aimed at giving an overview of the existing literature in performance measurement. The performance measurement literature is extremely dense. For example, between 1994 and 1996, one new paper on this topic appeared every five hours of every working day (Neely, 1998). Thus, the difficulty of the literature review stood in the sorting of
the scientific articles. First, a literature research of the traditional performance measurement and its evolution was conducted. Then, the literature research was more focused on the issue of implementation. A literature research has also been conducted in the field of performance measurement within construction industry, which was the field the company of the case study belongs to. The scientific articles have been found using the search engine of the Linköping University website through different databases (e.g. Academic Search Premier, Business Source Premier). The main key words used were: “performance measurement” and “key performance indicators”. Moreover, after the discovery of some “key” articles and authors (e.g. Mike Bourne or Andy Neely), the search was also carried out according to the references of these articles. Finally, I also referred to some books and articles provided by the library of Linköping University as well as by my academic supervisor.

2.3. Methodology for the empirical case study

As presented in the introduction, one of the main challenges of performance measurement is its implementation within an organisation. The design of the empirical case study allowed therefore getting a deeper understanding of the implementation theory by highlighting some similarities and gaps. Moreover, Bourne (2008, p.70) highlighted the effectiveness of conducting case study in the field of performance measurement and he added: “the ideal research situation would be in companies that are rolling out measures across the organization, where the process would allow observation of performance before, during and after the intervention”. The case study of the present thesis covered the phase “during the intervention” as well as a short view of before and after considering some local implementations in some factories of the company. Moreover, Denscombe (2007) explained that a case study is useful when trying to understand relationships and processes that have social components. The literature review and the case study of this present thesis show that performance measurement is really connected to social issues.

As previously stated, the empirical case study is based on an engineer internship. It means that I had a real mission to deal with and that the company expected practical results from me. The practical work entrusted to me essentially consisted in the implementation of dashboards of indicators in order to monitor performance in different departments and factories of the company. With the support of my manager and a member of a consultancy firm, I had the responsibility to implement performance measurement in three factories and other departments of the firm (e.g. commercial department, purchasing department, maintenance department). In order to be able to use this work in the thesis, the empirical case study defines at first the framework used for the implementation of performance measurement within ABC as well as the particularities of this case. It also describes the indicators’ dashboards implemented within the different factories and departments of ABC and it raises the main difficulties that I encountered during the implementations and how they have been overcome.
My tasks within the company consisted in identifying the needs of each actor as well as proposing some solutions in order to measure and analyse performance in their factory or department. In order to succeed in this task, I developed with the help of my manager and the member of the consultancy firm, a standard framework that should be implemented in the factories and departments. My role was then to work as a relay with the actors in the different factories and departments in order to implement and adapt the performance measurement framework in each case. This position of “relay in the field” allowed me to work at the core of the implementation. Moreover, it also allowed me conducting observations and interviews during the implementation phase, as well as to receive feedbacks.

The observations have been made during every implementation and were focused on the reaction of the people through all the implementation steps. From the company point of view, my role was really "practical-oriented" and was not to conduct observations for this present thesis. Therefore, I have been able to take notes after each working day regarding the three following main subjects:

- Direct feedbacks I received
- Conversations between employees
- My role within the implementation approach

Moreover, formal meetings have been conducted covering three hierarchical levels of the organisation. Table 1 and Table 2 thereafter aim at summarizing the formal meetings conducted within the organisation. These formal meetings have been divided in two kinds. The first kind of meetings dealt with all the interviews regarding the definition of the needs for each actor. These interviews occurred with the main managers at the beginning of each implementation and can be called “requirements interviews”. During these interviews, each factory or department manager presented the “current state” to me, as well as some problems or ideas regarding performance measurement. Then discussions were conducted in order to decide what would be implemented regarding the managers expectations and the standard framework I suggested. The other kind of meetings dealt with interviews regarding the progress of the implementations and can be called “feedbacks interviews”. These interviews covered a larger range of interviewees (i.e. every actor involved in the performance measurement approach) and occurred during the different implementations. Figure 4 below summarizes these two kinds of interviews.
Figure 4: Two kinds of formal interviews conducted at ABC

Table 2: Requirements interviews

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory manager 1</td>
<td>45 min</td>
</tr>
<tr>
<td>Factory manager 2</td>
<td>1 h</td>
</tr>
<tr>
<td>Factory manager 3</td>
<td>1 h</td>
</tr>
<tr>
<td>Sales manager</td>
<td>30 min</td>
</tr>
<tr>
<td>Purchase manager</td>
<td>1 h</td>
</tr>
<tr>
<td>Maintenance manager</td>
<td>30 min</td>
</tr>
</tbody>
</table>

Table 1: Feedbacks interviews

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Duration (~20min for each)</th>
<th>Number of interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory manager 1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Factory manager 2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Factory manager 3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Sales manager</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Purchase manager</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Maintenance manager</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Foreman 1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Foreman 2</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

As illustrated in Figure 4, I collected requirements in the first kind of interviews, and feedbacks in the other kind. In addition to these formal interviews, I conducted informal and unstructured interviews during the implementation phases in order to collect “deeper understandings” from the employees regarding how they perceived about the performance measurement approach that was being implemented in their factory or department. The content of these unstructured interviews was based on the main topics and questions presented in Table 3 thereafter. The goal of these interviews was to let the interviewees share every information they wanted to. These unstructured interviews were more designed for the field workers who have not been interviewed during the formal meetings presented before.
Table 3: Main topics of the unstructured interviews

<table>
<thead>
<tr>
<th>Topic</th>
<th>Examples of questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Understanding of the Performance Measurement System</strong></td>
<td>- How do you use these indicators?</td>
</tr>
<tr>
<td></td>
<td>- How do you perceive the Measure, Analyse, Act approach?</td>
</tr>
<tr>
<td><strong>Acceptance of the Performance Measurement System</strong></td>
<td>- Do you think it is relevant for the organisation?</td>
</tr>
<tr>
<td></td>
<td>- Do you think it is relevant for your work?</td>
</tr>
<tr>
<td></td>
<td>- Do you think it will help you to progress?</td>
</tr>
<tr>
<td></td>
<td>- What could be improved according to you?</td>
</tr>
</tbody>
</table>

2.4. **Methodology for the theoretical verification**

As illustrated in Figure 3, the thesis consists of two distinct parts: the theory of performance measurement, and a practical case of performance measurement within a company. The results of these two parts have been compared considering three main areas: the choice of the indicators, the design of the performance management system, and the practical implementation of the performance management system considering the key success factors, the barriers, and some other issues. According to these three areas, the method of the theoretical verification was to identify the similarities and gaps encountered between the theory and the case study.

2.5. **Method limitations**

The first limitation of this thesis comes from the fact that the empirical case study is based on one company only. According to Yin (2008), the use of multiple sources allows to increase the validity of the case study. Indeed, a single case study method offers poorer assurance for generalization of the results than a multiple case study method. However, I would argue that the case study of this thesis has the advantage to be based on a practical work that I have conducted. Indeed, regarding the importance of the practical issues in this field of performance measurement implementation, it can be expected that it could give a deeper understanding than a study only based on interviews. Bourne (2008) argued that in the field of performance measurement, case studies give more positive results than survey researches.

However, the fact that I used my own experience as empirical data could bring a bias in a sense that I might have a skewed opinion regarding what I have done and encountered during this internship. This bias has been handled by multiplying the number of the interviews with a large range of employees. Moreover, as illustrated in Figure 4, most of the interviews were designed in order to collect a large range of feedbacks regarding the implementation, which is a way to reduce the bias of my own experience.
Moreover, there were sometimes a kind of gap considering the practical and short-term oriented results expected from the company, and the more in-depth understanding which was needed for the thesis. Nevertheless, the parallel design used for this study allowed to take a step back when looking at the work done within the company.
3. Literature review

This chapter provides a literature review of performance measurement regarding its concern and evolution, and the concept of performance measurement system. Then, it aims at identifying the main recommendations and issues of performance measurement according to the literature. Finally, it presents the particularities of performance measurement within construction industry.

3.1. The concern for Performance Measurement

Performance measurement has been a topic of increasing concern for academics and practitioners. For example, survey data suggested that between 40 and 60 per cent of companies significantly changed their measurement system between 1995 and 2000 (Frigo and Krumwiede, 1999). Neely (1999) suggested seven factors that influence companies to start measuring their performance:

(1) the changing nature of work
(2) the increasing competition
(3) the specific improvement initiatives
(4) the national and international quality awards
(5) the changing organization roles
(6) the changing external demands
(7) the power of information technology.

Almost all these factors are based on what could be called “the changing environment” that seems to be a strong issue leading companies to measure their performance. Without performance measurements, managers tend to make their decisions only based on intuition and experience (Lantelme and Formoso, 1999). If it seems possible for companies to use intuition and experience for decision making in a stable and predictable context, it is really more hazardous in the current changing environment. Indeed, this need is usually expressed in many companies by the expression: “if you cannot measure it, you cannot manage it” (Niven, 2002).

Companies choose to measure their performance for various reasons (Neely et al., 1997): to know where they are, to know how rapidly they are improving, to enable comparison with other business (via Benchmarking), and also sometimes to influence individuals’ behaviours. This issue of human behaviour will be further detailed in the thesis, but Waggoner et al. (1999) already argued that people tend to give more importance to things that can be measured. Table 4 thereafter, developed by Neely (1998) shows multiple reasons why organizations measure performance. It aims at showing that all these reasons can fall in one of the four following distinct categories:
(a) Check position  
(b) Communicate position  
(c) Confirm priorities  
(d) Compel progress

(a) groups the reasons regarding the establishment of the current status, as well as the monitoring of progress over time. (b) deals with the release of reports (e.g. annual safety statistics). It may be expected by customers or employees and can be a way of marketing themselves. (c) deals with the insights of what is important for the company, aiming at focusing on what the priorities should be. Finally, (d) deals with the fact that measures can help organisations to focus on specific issues and motivate employees to look for ways to improve performance.

**Table 4: Why companies engage in performance measurement (Neely, 1998)**

<table>
<thead>
<tr>
<th>Why measure?</th>
<th>Check position</th>
<th>Communicate position</th>
<th>Confirm priorities</th>
<th>Compel progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>To establish position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To monitor progress</td>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because the organisation has to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because the organisation wants to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>communicate performance to shareholders or customers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because the organisation or others want to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>be able to benchmark performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures stimulate interest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures can be used to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>communicate priorities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a means of motivating people to look for ways of</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>improving performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a basis for reward</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a means of management control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a an insight into what is important for the customer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a an insight into what the business is doing well</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide an insight into what the business is not doing well</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a an insight into what the business needs to focus on</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Because measures provide a an insight into where the business should invest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.2. The evolution of Performance Measurement

For a long time, financial measures have been used to evaluate performance of organisations. During the 1980s, this traditional concept of performance measurement, based on financial issues, has been strongly criticized. There was a growing awareness that, given the increased complexity of organisations and markets, this kind of measures was no longer appropriate. There were two main criticisms about the traditional performance measurement (Kaplan and Norton, 1996):

1. Traditional performance measurement is financially driven
2. Traditional performance measurement is historically focused

The first criticism was shared by numerous authors, and already in the 1974 by Skinner, who argued that the main cause of performance troubles encountered by companies comes from the fact that managers tend to use simplistic notions in performance measuring, only based in cost and efficiency. Skinner (1974) argued that there are many more criteria to measure performance. The remark suggests that one problem with traditional performance measurement is that it adopted a too narrow and unidimensional focus. The second criticism reveals that traditional performance measurement was only used to look at what have been done before and did not offer the opportunity for improvement. The literature revealed other criticisms of performance measurement, such as:

- Encouraging short termism (Banks and Wheelwright, 1979; Hayes and Garvin, 1982)
- Lacking strategic focus (Skinner, 1974)
- Encouraging local optimization (Hall, 1983; Fry and Cox, 1989)
- Encouraging minimization of variance rather than continuous improvement (Johnson and Kaplan, 1987; Lynch and Cross, 1991)
- Not being externally focused (Kaplan and Norton, 1992)

In the late 1980s and early 1990s, these criticisms led to the development of “more balanced” or “multi-dimensional” performance measurement frameworks. Keegan et al. (1989) proposed a balance between internal and external measures and between financial and non-financial measures. Cross and Lynch (1988-1989) described a pyramid of measures which integrates performance through the hierarchy of the organization. Fitzgerald et al. (1991) distinguished between the results and their determinants. All these frameworks are complete, but really hard to operationalise. Indeed, Neely et al. (2002) noticed that these frameworks are too open and can be interpreted in too many different ways. The most famous framework is the Balanced Scorecard (BSC) from Kaplan and Norton (1992). The BSC aims at enabling managers to design their measures according to four perspectives as showed in Table 5:
The balanced scorecard has been widely implemented in companies. If there are several examples of success, many companies encountered difficulties for its implementation. According to Bourne (2008), non-financial KPIs are more difficult to design and use than accounting measures. Another famous framework is the “Performance Prism” developed by Neely et al. (2002). This structured framework aims at underlining the complexity of the organisation’s relationships with its different stakeholders.

Moreover, in order to assess performance, it is important to weigh the different indicators in order to be able to consider the different priorities of each indicator (Olson and Slater, 2002). The indicators with the highest priorities are usually called the Key Performance Indicators (KPI). According to Brook (2010), KPIs need to reflect the “Voice of the Customer”. Therefore, the author recommended to break down the Voice of the Customer into some “Critical to Quality” specifications from which the KPIs can be derived.

Unfortunately, performance measurement is not sufficient to increase performance by itself. Bourne (2008, p.68) argued that organisations must be aware of the fact that a KPI is just an indicator, not actual performance itself: “Measurement just keeps the score. So, to improve, you need to change what you do, or do it more effectively, something that measurement may encourage, but measurement alone does not create value.” A framework is needed in order to enable organisation to use performance measurement so as to increase performance.

### 3.3. The Performance Measurement System

Researchers agreed that performance measurement must be part of a system, in order to implement a mechanism (e.g. Neely et al, 1997; Lantelme and Formoso, 1999; Bourne et al, 2000). It is called the performance measurement system (PMS). Bourne et al. (2000) argued that the fact of measuring is only one part of using the measures and that a “forum” is required to review the measures and take actions. Some authors show that the translation of the measurement results in action is crucial in order to be able to improve performance: “Although choosing the right measures is important, it is also necessary to enable people to use measures in their daily routine work, so that root causes of problems are identified and corrective action implemented.” (Lantelme and Formoso, 1999, p.1). A model of the development of a PMS, showed in Figure 5, has been proposed by Bourne et al. (2000). This development model can be divided in three phases:

<table>
<thead>
<tr>
<th>The financial perspective</th>
<th>➔ How do we look to our shareholders?</th>
</tr>
</thead>
<tbody>
<tr>
<td>The internal business perspective</td>
<td>➔ What must we excel at?</td>
</tr>
<tr>
<td>The customer perspective</td>
<td>➔ How do our customers see us?</td>
</tr>
<tr>
<td>The innovation and learning perspective</td>
<td>➔ How can we continue to improve and create value?</td>
</tr>
</tbody>
</table>
(a) The design of the performance measures  
(b) The implementation of the performance measures  
(c) The use of the performance measures  

The design phase can be divided again into: identifying the key objectives to be measured and designing the measures themselves. For the categorisation within this framework, the authors defined in their study the word “implementation” as the step where the procedures are put in place to collect the data. The use of performance measurement is then divided into: the use of measures to assess the implementation of the strategy and the use of measures to challenge strategic assumptions.

<table>
<thead>
<tr>
<th></th>
<th>(a)</th>
<th>(b)</th>
<th>(c)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System design</td>
<td>Implementation of measures</td>
<td>Use of measures to assess the implementation of strategy</td>
</tr>
<tr>
<td></td>
<td>Identifying key objectives</td>
<td>Designing measures</td>
<td>Initial collection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Collation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorting / analyse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 5: Phases in developing a PMS (Bourne et al., 2000)**

In addition to offer a segmentation of the different development phases, this model also contains four processes in order to update the performance measurement system over time:
(1) Reviewing targets  
(2) Developing measures  
(3) Reviewing measures  
(4) Challenging strategy

These four processes make the linear three-phases process become cyclic by adding some review loops at different levels. The loops (1), (2) and (3) can be followed during the phase of using measures to assess the implementation of strategy. The loop (1) deals with the review of operational goals. The loop (2) deals with the characteristics of performance measurement: *i.e.* are the measures well designed? The loop (3) deals with the review of the dimension of the measures: *i.e.* do the measures focus on the right things? The last loop (4) is used on a more long-term approach in order to challenge the strategic assumptions.

In order to go deeper in the details of a PMS, Hudson *et al.* (2001) developed a typology in order to identify the characteristics of a well-designed performance measurement system. This typology is divided into three categories: the development process requirements, the characteristics of performance measures, and the dimensions of the measures. The development of a process requirement, illustrated in Table 6 is divided using the framework of Platts (1994): point of entry, participation, procedure, and project management.

**Table 6: Requirements for developing a PMS process (Hudson et al., 2001; Platts, 1994)**

<table>
<thead>
<tr>
<th>Point of entry</th>
<th>Audit of the existing PMS, area of deficiency, need for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation</td>
<td>Key users of the PMS</td>
</tr>
<tr>
<td>Procedure</td>
<td>Identifying strategic objectives</td>
</tr>
<tr>
<td></td>
<td>Performance measure structure</td>
</tr>
<tr>
<td></td>
<td>Periodic maintenance structure</td>
</tr>
<tr>
<td>Project management</td>
<td>Top management support</td>
</tr>
<tr>
<td></td>
<td>Employee involvement</td>
</tr>
<tr>
<td></td>
<td>Clear explicit objectives</td>
</tr>
<tr>
<td></td>
<td>Time framed project management</td>
</tr>
</tbody>
</table>

The characteristics of performance measurement are based on the recommendations of Neely *et al.* (1997). The authors argued that measures must: be derived from strategy, be clearly defined with an explicit purpose, be relevant and easy to maintain, be simple to understand and use, provide fast and accurate feedback, and stimulate continuous improvement. Finally, the dimension of the measures deals with their focus. In their typology, Hudson *et al.* (2001) set the main dimensions as: quality, time, flexibility, finance, customer satisfaction, and human resources.
3.4. The implementation of Performance Measurement Systems

The previous typology of Hudson et al. (2001) aimed at identifying the characteristics of a successful PMS. Moreover, Anderson (1996) stated five attributes for a successful PMS:

(1) Acceptable \(\rightarrow\) it should be understood
(2) Suitable \(\rightarrow\) it should measure important things
(3) Feasible \(\rightarrow\) the cost of data collection should not be too expensive
(4) Effective \(\rightarrow\) it concentrates on encouraging the right behaviour
(5) Aligned \(\rightarrow\) non-financial measures must link to financial goals

These characteristics are important since they set the goals of a successful PMS. However, it does not deal with the practical issues when implementing PMS. Bourne et al. (2002) have conducted a case study including unstructured interviews in ten companies divided in two groups: those who successfully implemented performance measurement and those who did not. In their study, a successful implementation occurs when the management uses the majority of the measures in the management of their business. The following part regarding the key success factors and the barriers of performance improvement is mainly based on their results. Other literatures are included in order to get different advices.

3.4.1. Key success factors for implementation

Bourne et al. (2002) showed in their study that the main reason for continuing performance measurement was the insight of its benefits. Indeed, every interviewee from the successful companies of their case study commented on the fact that they early perceived the benefits from performance measurement. On the contrary, the perceived lack of benefits was largely cited by the interviewees from the unsuccessful companies. This was also underlined by other studies (e.g. Bourne et al., 2000; Lantelme and Formoso, 1999) showing that several managers do not see the benefits of performance measurement and have other priorities whose the results are more short-term oriented. This key success factor also reveals a problem in a sense that measurement benefits cannot give results on the short term and sometimes leads managers to loose motivation for implementing performance measurement. Therefore, before implementing performance measurement, the organisation must ensure that the managers perceive its benefits in order to conduct an effective implementation.

The second key factor success according to Bourne et al. (2002) was the top management commitment. This issue was already well documented in the change management literature (e.g. Kotter, J.P., 1995) so this key success factor is not unexpected. It was indeed cited by all the interviewees as a reason for continuing the implementation. Moreover, as showed in Table 3, the top management support is a requirement for developing a PMS process according to Hudson et al. (2001).
As it will be discussed in the next part, the **time and effort required** is often a barrier to performance measurement, but in the study of Bourne et al. (2002), it was raised by some companies as a reason for continuing because interviewees believe the results were worth the time and effort required. It appeared to be linked to the insight of the benefits of performance measurement. Indeed, if people see the benefits of implementing measures, then the time and effort are really justified. The difficulty is that the result usually comes after the effort, which is the reason why the management role is really important. Therefore, these three first keys of success (insight of benefits, management commitment, and worth effort) can be consider as linked because that is the management role to make a trade-off between effort and benefits (Bourne et al., 2002).

As previously stated, performance measurement must be **part of a structured system** in order to be able to translate the results of the measures into effective actions. Based on some literature recommendations, Neely et al. (1997) set a “Performance measure record sheet” aiming at simplifying the process of designing appropriate measures. For each measure, the sheet allows to clearly define its title, its purpose, what it is related to, the target, the formula, the frequency of measurement, the source of data, who act on the data as well as what they do.

Another key issue when implementing performance measurement is the **link with the strategy** (Neely et al., 1997). The need for organisations to align their performance measurement systems with their strategic goals is well-documented in the literature. For example, when developing the “Performance Prism”, Neely et al. (2002) explained that the setting of strategy could be seen as a **route** to a destination, and that the destination was the stakeholder satisfaction. Therefore, linking measures to the strategy aims at assessing that the organisation follows the right route. Moreover, looking back at Figure 5, the model developed by Bourne et al. (2000) contains a phase of using measures to assess the strategy, as well as a phase of challenging the strategic assumptions. These two phases make a linkage between measure and strategy, which is crucial for the working of an organisation. The second phase, allowing to challenge the strategic assumptions will be further illustrated in the thesis by an example in the part about the performance measurement issues.

According to Table 6, one of the requirements of PMS which deals with project management is **employee involvement**. Indeed, it is really important to involve the entire organisation in performance measurement, and in order to succeed it, Lea and Parker (1989) suggested that performance measurement should be transparent. More in details, they argue that performance measurement should: be simple to understand, have a visual impact, focus on improvement rather than variance, and be visible to all. Similarly, Lantelme and Formoso (1999) argued that a successful performance measurement system can be achieved only if the measures are made available using an adequate visual presentation for everyone in the company. These last authors suggest that a way of involving people is to set some “moments for reflections”. These moments of reflection will also aim at developing system thinking within the whole organisation. System thinking is a way of thinking that allows to properly understand the different variables that affect the results and it leads to increase the confidence of the
managers when they use the measures, because they correctly represent the process and the results (Lantelme and Formoso, 1999).

According to Lantelme and Formoso (1999), Benchmarking against other companies is really important in performance measurement since it allows managers to consistently revise processes and compare their performance to the competitors. Benchmarking allows the establishment of challenging goals that must be linked to the company’s strategic objectives and that will drive continuous improvement. Benchmarking is also really important to set the level of the warning in the different graphics and to avoid the use of intuition only. Indeed, performance measurement is effective when there is a level to achieve and Benchmarking must be used to define this level in order to remain competitive. Benchmarking is the key to add value to performance measurement (Beatham et al., 2004).

Several authors give importance to the simplification of performance measurement by recommending to reduce the number of measures and to make it easy to understand for everyone (Lantelme and Formoso, 1999; Neely et al., 1997). Besides, they argue that simplification will lead to a less time and less cost expensive data collection. Lantelme and Formoso (1999) also argued that the cycle time to provide the information of measurement must be reduced so as to increase motivation. They recommend for that to reduce the number of the measures and to automate the data collection. Moreover, Hudson et al. (2001) recommended using some iterative processes in order to maintain the “momentum and enthusiasm of the development team”.

Table 7 below aims at summarizing the main success factors previously discussed:

<table>
<thead>
<tr>
<th>Main key success factors for PMS implementation</th>
<th>Literature supporting the factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived benefits of performance measurement</td>
<td>Bourne et al. (2002); Bourne et al. (2000); Lantelme and Formoso (1999)</td>
</tr>
<tr>
<td>Continued top management commitment</td>
<td>Bourne et al. (2002); Hudson et al. (2001)</td>
</tr>
<tr>
<td>Worth effort</td>
<td>Bourne et al. (2002)</td>
</tr>
<tr>
<td>Structured framework</td>
<td>Bourne et al. (2000); Lantelme and Formoso (1999) ; Neely et al. (1997)</td>
</tr>
<tr>
<td>Link to the strategy</td>
<td>Bourne et al. (2000) ; Neely et al. (1997); Neely et al. (2002);</td>
</tr>
<tr>
<td>Employee involvement</td>
<td>Hudson et al. (2001); Lea and Parker (1989); Lantelme and Formoso (1999)</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>Beatham et al., (2004); Lantelme and Formoso (1999)</td>
</tr>
<tr>
<td>Simplification of the measures</td>
<td>Lantelme and Formoso (1999); Hudson et al. (2001); Neely et al. (1997)</td>
</tr>
</tbody>
</table>
3.4.2. Barriers for implementation

In their study, Bourne et al. (2002) found that the time and effort required was the most frequently cited reason by the interviewees for not continuing performance measurement. Indeed, all the companies that implemented PMS faced the issue of lack of time and resources since PMS needs a consequent effort. Bourne (2008) saw this issue as a real dilemma for the organisation: “how do we manage today whilst preparing for tomorrow?” It means that in order to perform well, the organisation need to deploy resources that focus on the near future. As previously stated, this issue of time is connected to the perceived benefits and to the top management commitment: if managers do not see the benefits of performance measurement, they will not allow enough time for its implementation.

Another important barrier deals with human behaviour. Indeed, the second barrier identified by Bourne et al. (2002) was what they called “the personal consequences of implementing performance measurement”. The authors observed some resistances, from both employees and managers. Indeed, some employees who are being measured are in fear of “personal attacks on themselves”. Moreover, some managers refuse to implement performance measurement because they think it will lead to adverse performance to the organisation. Beatham et al. (2004) argued that when implementing measure, humans could be seen as “calculative receptors” and performance measurement has therefore an important behavioural impact. Indeed, people tend to modify their behaviour in order to ensure a positive perceived performance even if this means taking inappropriate actions (Neely et al., 1997). A good example was given by Fry and Cox (1989) in a company where the implementation of measures of the production output led to the decision to increase the batch sizes and thus to decrease the production efficiency because the products were spending more time in the system than before. In this case, the chosen measures were not wrong, but the behaviours they tend to induce had not been considered. Turney and Anderson (1989) argued that one problem with accounting systems is that management is sometimes focused on the wrong things. The cultural part is really important and Lantelme and Formoso (1999) argued that some company cultures lead managers, when analysing the results, to look mainly for “who or what is to blame for the existing problems instead of focusing on process improvement”. However, some authors show that, when handled properly, this behavioural component can be used as a success factor. For example, Boussard (2001) showed the existence of “pregnant indicators” in the organizations. These indicators are those to which the employees give their interest. The pregnant indicators make sense for them and the employees believe that these indicators represent their activity in the best way. Then, these indicators can serve as tools for the actors in order to reinforce their role in the organization (Boussard, 2001).

Bourne et al. (2002) showed in their case study that data access was a recurring problem both in the successful and unsuccessful companies. It can be a technical problem such as inappropriate IT systems that are unable to give significant data. It can also be an organisational problem. This organisational problem is sometimes linked to the lack of people and time to collect the data (Lantelme and Formoso, 1999). Moreover this organisational problem can also be linked to human behaviour. Indeed, there is sometimes a resistance from
the managers because they have fear about the fact that measurement system redistributes access to information and that it could reduce their power (Bourne et al., 2000).

The successful companies in Bourne et al. (2002) case study overcome difficulties concerned with the development of appropriate measures. This is an unescapable barrier that needs to be overcome. It shows that the managers have understood the importance of defining appropriate measures. Measures are appropriate when they provide a fast and accurate feedback (Neely et al., 1997) and thus when they allow taking decisions and actions. Appropriate measures will help to find the cause and effect relationships as well as any correlation between the indicators. Nonetheless, drawing quantitative relationships between performance indicators require generally several years of study (Kaplan and Norton, 2004).

Finally, there is the barrier of employee skills. Indeed, lots of organisations do not know how to manage with measures (Bourne, 2008). Sometimes, the problem comes from the lack of people with experience and knowledge on collecting and evaluating data (Lantelme and Formoso, 1999). Indeed, performance measurement requires technical skills to be able to collect the data and to use them properly. It also requires strong human skills in order to be able to avoid the perverse effects of performance measurement. This perceived lack of skills in performance measurement is a main factor leading some companies to ask for the expertise of consulting firms.

Table 8 below aims at summarizing the main barriers previously discussed:

### Table 8: Barriers for PMS implementation

<table>
<thead>
<tr>
<th>Main barriers for PMS implementation</th>
<th>Literature supporting the barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time and effort required</td>
<td>Bourne et al. (2002); Bourne (2008)</td>
</tr>
<tr>
<td>Human behaviour</td>
<td>Beatham et al. (2004); Bourne et al. (2002); Boussard (2001); Fry and Cox (1989); Lantelme and Formoso (1999); Neely et al. (1997); Turney and Anderson (1989)</td>
</tr>
<tr>
<td>Data access</td>
<td>Bourne et al. (2002); Bourne et al. (2002); Lantelme and Formoso (1999)</td>
</tr>
<tr>
<td>Finding appropriate measures</td>
<td>Bourne et al. (2002); Neely et al. (1997)</td>
</tr>
<tr>
<td>Employee skills</td>
<td>Bourne (2008); Lantelme and Formoso (1999)</td>
</tr>
</tbody>
</table>
3.5. Managing change in Performance Measurement

In the 80s and 90s, the literature focused on “what” to measure. Then, it focused on “how” to measure and “how to manage” through PMSs. More recently, the literature focused on how to keep performance measurement relevant and how to update it over time. Most measurement initiatives appeared to be static, stable and predictable (Kennerley and Neely, 2002). However, the rapidly changing business environment should lead organisations to implement processes in order to ensure that their PMS is updated and still relevant according to their strategy. Neely et al. (2002) argue that: “a performance measurement system is a living entity which must evolve and be nurtured over time”. Nevertheless, most of the PMSs fail to change when organisations change and Kennerley and Neely (2002) identified four categories of barriers for PMS changing:

(1) Process: the absence of an effective process
(2) People: the lack of the necessary skills and resources
(3) System: inflexible systems
(4) Culture: inappropriate culture

Moreover, it appears that managing change in performance measurement is often really difficult because the existing measures are maintained in place by considerable forces (Berry, 1983). The existing measures aim at creating a relative consistency in the organisation. However some authors provide some frameworks for handling the review of PMS. For example, Sallum and Myrelid (2012) have developed a process-based framework divided in a top-down and in a bottom-up approach. The top-down approach, aims at first ensuring that the strategy is reviewed, and then cascading the reviewed strategy in the different management levels by creating some target letters (divided in quality, delivery, cost and environment), and action-lists. The bottom up approach first contains the review of the structure (roles, meetings, templates…). The authors argue that the structure is essential for creating a common language and foundation within the organisation. Then, they describe an organisational process, showed in Figure 6, which allows people to ask the good questions: “Why shall we do anything? What should we do? How shall we work? What are our results? What have we learned?” The process is important in order to develop the skills and the understanding of the people involved.

![Organisational process to review PMS (Sallum and Myrelid, 2012)](image-url)
3.6. Performance Measurement issues

The main key success factors and barriers for implementing a PMS have been previously defined. However, there are some important issues, such as the reduction of the complexity and the organisational learning that are quite difficult to categorize in term of success factors and barriers since they are inherent to performance measurement. These issues are discussed in turn:

3.6.1 Different kinds of measures

First of all, it is important to differentiate two types of measures (Beatham et al., 2004): the “lagging” measures and the “leading” measures. The lagging measures are used as a historic review to assess completed performance results and do not offer the opportunity to change performance. However, the leading measures offer the opportunity to change since they continuously measure performance. They enable predicting future performance and taking decisions based on the results of previous activities. The European Foundation for Quality Management (EFQM) Excellence Model identifies three specific types of measures: the KPIs, the KPOs (Key Performance Outcomes) and the perception measures. The KPIs are measures indicative of performance processes. They are used as leading indicators and allow to identify problems and to highlight the need of further investigation. They provide opportunity to change by taking appropriate corrective actions. For that, the KPIs need to be continuously measured during the process. The KPOs are results of a completed process. They are lagging indicators and do not offer the opportunity to change since they are backward focused. Finally, perception measures can be used at any stage of a process and can be leading or lagging measures and require direct feedback on past performance. For example, perception measures can be used to assess customer satisfaction (Beatham et al., 2004).

3.6.2 Reduction of the complexity

An important issue of performance measurement systems is that they aim at facilitating the decision making because they operate a simplification of the real world. According to the previous part, simplification has been identified by Lantelme and Formoso (1999) as a key success factor: the authors recommend trying to reduce the number of indicators to use, which makes the data collection less expensive. Another advantage they see in the reduction of the complexity is also to allow a better understanding by all the involved actors in the company. However, Berry (1983) warned us about this process of simplification of the real world which can turn out to be dangerous. The author showed that every management situation has a complexity that exceeds the analysis capacity of human beings. Though, Berry (1938) showed that the performance indicators tend to give us some “abbreviations of the truth” and “abbreviations of the good” that constitute shortcuts and lead to a “decisions automation” allowing to save time, but also to skew the decisions makings.
3.6.3 Local approaches and global consistency

Another issue of performance measurement system is that it is often built in a way that the indicators, applied at each part of an organization are specialized and partial. Therefore, according to Berry (1983), the indicators are the means of a vigilance division, because the specification of the criteria makes impossible a global consistency of the choices. Furthermore, the author shows that the research of local optimums does not necessary lead to a global optimum.

3.6.4 Organisational learning

Organisational learning is a concept which differs from individual learning by the fact that organisation, unlike individuals, maintains a learning system that lasts in time and influences immediate and future members of the organisation (Martin, 1982). The difference between individual and organisational learning has been stated by Hedberg (1981, p.6) in this way: “Although organisational learning occurs through individuals, it would be a mistake to conclude that organisational learning is nothing but the cumulative result of their members’ learning. Organisations do not have brains, but they have cognitive systems and memories. As individuals develop their personalities, personal habits, and beliefs over time, organisations develop world views and ideologies. Members come and go, and leadership changes, but organisations’ memories preserve certain behaviours, mental maps, norms, and values over time”.

The implementation of PMS can support the organisational learning process by enabling managers to clearly understand the changes that take place during the implementation (Lantelme and Formoso, 1999). However, many organizations face difficulties to “learn how to learn” and prefer to hire consulting companies to help them when they need instead of using their internal capabilities (Lantelme and Formoso, 1999). Senge (1990) identified two main barriers to learning in organizations: the way individuals have been trained to think and act and the fact that organizations are not used to find their own solution for problem solving. Neely and Al Najjar (2006) offered a good explanation of organisational learning with a case study at British Airways. They showed the importance of identifying the correlation of the different factors that drive performance by conducted an “Integrated Performance Analysis” instead of analysing performance independently as it is traditionally done. In their case, the authors identified a counterintuitive negative correlation when analysing the factors correlation that lead to customer satisfaction: “When plane leave late, passengers tend to report that cabin crew service is better”. The explanation can come from the fact that the cabin crew have more time to take care of the passengers before take-off, and consciously or not deliver superior service to calm down any potential frustration. What is interesting in this case is the fact that these unexpected links provide the opportunity for management learning, since they compel managers to challenge their assumptions about their performance model, strategic assumptions and how business operate in general.
Moreover, the theory distinguishes two main approaches of organisational learning: the single-loop learning and the double-loop learning (Argyris, 2002). In a changing environment, the single-loop learning occurs when people simply change their actions and the double-loop learning occurs when people question theories, knowledge, behaviours and other variables that lead change. Argyris (2002, p. 206) stated the following definition of the double-loop learning: “Double-loop learning occurs when errors are corrected by changing the governing values and then the actions. A thermostat is double-loop learning if it questions why it is programmed to measure temperature, and then adjusts the temperature itself”.

3.7 Performance measurement in construction industry

The implementation of PMS in the construction industry is a relatively difficult task for two main reasons (Lantelme and Formoso, 1999). First, construction is a project-oriented industry which manufactures a product usually unique. Secondly, construction projects tend to be relatively complex due to the variety of materials, the many different involved agents, and final product which has lot of performance attributes. Therefore, a relatively small number of construction companies have been able to implement performance measurement. The main identified reason was the lack of people and time for implementing measures (Lantelme and Formoso, 1999). Nevertheless, numerous organisations have worked on the subject of finding KPI for the construction industry. For example, the Construction Best Practice Programme (CBPP) launched ten headline KPIs in 1998: client satisfaction, product and service, profitability, productivity, defects, safety, predictability, time and cost, construction time, and construction cost. In this particular context of construction industry, it is important to recall the difference between productivity measurement and performance measurement: productivity measurement is only one part of performance measurement (Cox et al., 2003). Current performance is usually measured against historical data. Indeed, knowing past performance gives a reference point to measure future performance (Alfred, 1988). Cox et al., (2003) argued that performance can also be measured against planned performance in order to get a sense of effectiveness.

Cox et al. (2003) defined a set of KPIs by differentiating quantitative and qualitative indicators. Quantitative indicators are the most commonly accepted and used. They can be physically measured in money, unit, or man-hour (MH). Cox et al. (2003) listed some quantitative performance indicators in construction industry showed in Table 6:
Table 9: Quantitative KPI in construction industry (Cox et al., 2003)

| Units / MH |  |
| $ / Unit |  |
| Cost |  |
| On-Time Completion |  |
| Resource Management |  |
| Quality Control and Rework |  |
| Percent complete |  |
| Earned MH |  |
| Lost Time Accounting |  |
| Punch List |  |

Regarding Table 9, the indicator “Cost” deals with the comparison between the current and the budgeted costs. The indicator “Resource Management” deals with the amount of materials, tools and equipment needed. The “Quality Control and Rework” is an important indicator in construction industry since rework usually represents 6-12% of the overall cost for a construction project (Cox et al., 2003). The indicator “Lost Time Accounting” deals with the wasted hours with no return (e.g. waiting times). Finally, the Punch list is the list of the completion works that the customer requires from the company before signing the contract. It aims at giving a good indication of the completeness and quality of the work done in the construction process since it represents the items that either have not been completed, or present some defects at the moment of the reception by the customer. There are different ways to report punch list items such as counting the number of punch items or the number of MH required to complete them.

Qualitative indicators are not commonly accepted and used because of their difficulty to be measured. However, these qualitative indicators are really important for a construction project and Warren (1989) argued that who do not include qualitative indicators may fail an opportunity to improve their performance. Cox et al. (2003) listed some qualitative performance indicators in construction:

Table 10: Qualitative KPI in construction industry (Cox et al., 2003)

| Safety |  |
| Turnover |  |
| Absenteeism |  |
| Motivation |  |
According to Table 10, “Safety” has now become the major concern for every construction industry. Besides, poor safety has a detrimental impact on the work. The work accidents may lead to stop one area, to drop the worker morale and to decrease productivity (Alfred, 1988). “Turnover” is also usually indicative of the construction industry performance since high percentages often lead to lower skills on the site that affect the quality of the work. Moreover, it has a cost for the training of the new employees. “Absenteeism” can be expressed in term of lost MH for the construction projects. Finally, “Motivation” is the most difficult indicator to measure, but it is argued that it can have a strong positive impact on performance (Warren, 1989). According to the study of Cox et al. (2003), there are six of these previous quantitative and qualitative KPIs that are more significant for the current practitioners. These are: Quality Control and Rework, On-Time completion, Cost, Safety, $/Unit and Units/MH.

However, the current use of performance measurement in the construction industry has been criticized. Beatham et al. (2004) argued that construction industry does not distinguish between the different types of measures described earlier and refers all measures to KPIs. Nonetheless, they argue that most of the CBPP KPIs are in fact KPOs which do not offer the opportunity to change. Beatham et al. (2004) explained that there is a lack of certainty in the data due to different procurement ways and due to a lack of validation of the results. They argue that in many construction companies, measures are more used as a marketing tool than as an improvement tool. This lack of validation led the companies to develop their own set of KPI, which makes really difficult to conduct a Benchmark aiming at comparing data according to the clients’ benefits. Therefore, companies are only able to benchmark themselves, which offers the least opportunity for improvement (McGeorge and Palmer, 1997). However, Beatham et al. (2004) showed that the only KPIs related to people results, safety and client satisfaction offer the opportunity to change because they can be used to benchmark against other industries. Regarding safety, it is also due to the fact that this is a legal requirement which is continuously measured through the project.
4. Empirical case study

After a presentation of the context, this chapter aims at giving the main results of the case study, i.e. the description of the practical PM implementation within ABC, a presentation of some implemented indicators dashboards, as well as the main facilitators and difficulties encountered during the practical implementation.

4.1. Context of the case study

ABC is a French company specialized in the industrialized modular construction. The industrialized modular construction consists in the pre-construction of a building within a factory. Each building is divided in modules which are built at 80-90% in the factory. Then, the modules are transported by truck and finally assembled on the construction sites with the necessary finishes. This construction process especially offers cost and delay advantages compared to the traditional construction. For forty years, ABC Company has built modular constructions for sell and for rent with different ranges of products. The company has three main factories quite close to each other where the different products are built. The customers can be private companies as well as public communities. For example, ABC buildings can be: worksite huts, companies head offices, schools, restaurants, hospitals, clinics or laboratories. ABC is a family-owned company which has experienced a strong growth during the last ten years, both economical and regarding the number of employees. This fast evolution has needed some changes in the structure and in the organization of the company. For example, the Industrialization, Methods and Maintenance (IMM) department has been created only four years ago. During a six month period, I integrated this department which constitutes an essential interface between the Design Offices and the Production by defining the different processes, the operating modes and by improving the working conditions in order to optimize production. The department is also responsible for the deployment of the CI approach. This approach is coached by a consulting company and has started at the beginning of 2012. In the framework of the CI approach, and helped by a member of the consulting company, my practical work has essentially consisted in the implementation of dashboards of indicators in some monitoring rooms in order to monitor performance in different services and factories of the company. The implementation was partly based on the AFNOR recommendations (French organisation for normalization).

The assessment of the current situation at ABC has been presented to me as follows: “At ABC, the problems are handled instantly, but there are really few feedbacks on the dysfunctions and also few information exchanges between the departments in order to solve the problems”. In order to answer this problematic, the CI approach at ABC is articulated as shown in Figure 7:
Figure 7: The different axes of the ABC CI approach (ABC)

Figure 7 illustrates the different tools that support the CI approach within ABC. Performance measurement plays a central role in the CI approach. Indeed, when starting to look at the item “Performance monitoring” in Figure 7, the graph shows that the creation of a monitoring structure should allow making the performance visible. Thus, it should also allow measuring the non-performance, analysing its root causes, and defining the improvement actions to implement. Then, the implemented actions should be monitored. That is the reason why the consulting company works on the managerial posture with the involved actors. Thanks to an adequate managerial posture (such as “Nice: a problem!”), the actors are then able to use some problems solving tools. Finally, some rituals, which are short meetings at fixed time aims at communicating around the performance, the encountered problems, the implemented actions as well as the actions to implement.

As previously stated, the lack of communication around the encountered problems was a main problematic at ABC. Therefore, the approach has started with the implementation of “improvement sheets”. The improvement sheets are communication material aiming at communicating the problems within a factory or a department and also across different factories or departments. The issued improvement sheets are then classified in a board which provides a support for a weekly ritual.
4.2. A practical implementation of Performance Measurement

This part aims at describing the overall design of the PMS as well as its implementation within ABC. It explains how the indicators dashboards have been built. Some of these dashboards are then described in turn.

4.2.1. The overall design of the PMS

As shown in Figure 8 thereafter, the company PMS is divided in three hierarchical levels: the “Big Room”, the “Medium Rooms” and the “Field”. Originally, the word “Obeya” which means “Big Room” in Japanese is a concept used for the product development within Toyota factories. This Big Room constitutes a major monitoring tool since it allows the visual management of a whole project in a unique place. Some graphs and synthesis charts are displayed on the walls, as well as some ongoing corrective actions in order to solve the problems. The managers meet regularly in this monitoring room. The goal is to ensure the monitoring and to reduce the cycle of the Plan-Do-Check-Act (Andersson and Bellgran, 2009). Within ABC, this concept of monitoring room in declined according to the three discussed hierarchical levels.

The Big Room

First, the Big Room receives a monthly ritual with the industrial director and the factories directors. The industrial direction set the objectives by writing and communicating the Industrial Master Plan. It contains the strategy of the company, broken down in several axes that are cascaded to each department and factories of the company.

The Medium Rooms

Then, the Medium Rooms receive weekly rituals. There is one Medium Room by factory or department. The ritual in the factories Medium Rooms includes the factory manager, the workshop manager, the foremen and the scheduling manager.

The Field

Finally, the different objectives of each department and factory are cascaded to the Field. The Field monitoring is conducted with the support of “Totems”. A Totem is a visual support that displays simple indicators for the field workers. A Totem is attached to a workstation or a “business area”. Indeed, at ABC, the workshops are mainly divided in business areas. One business area consists in the construction of one building for one customer where the different categories of workers do their own job (plumbers, roofers, electricians…). If I could make a
short aside, it is important to notice that these “business areas” makes ABC a quite special factory where there is no really continuous flow within the whole plant. However, the IMM department is currently implementing some fixed workstations when it is possible (e.g. fixed workstation for the roof or the floor) in order to optimize the production. A Totem, aimed at giving information to the field workers, is divided in three parts: Safety, Quality and Main Objectives according to the state of progress of the work. In front of a Totem takes place a daily ritual led by a foreman. The foreman is responsible for one part of the workstations or business area that he first goes through in order to fill in the Totem, and then presents it in front of working teams. The Totem aims at giving the priorities to the teams.

The Totem is also used to communicate from the Field with the improvement sheets. Each Totem has some blank improvement sheets that the workers can fill in when they encounter a problem. A filled sheet is then issued on the improvement sheets board during the factory weekly ritual that aims at improving the “Supplier → Customer” relationships within the whole organisation. The setting of the Totems is really important because they are those which should make the link between the Medium Rooms indicators and the Field, where actions can be conducted.

Finally this design is also supported by a daily production meeting of the industrial director and the three factory managers.

**Figure 8:** Overall design of the ABC PMS (ABC)
As illustrated in Figure 8, the indicators of the monitoring rooms are divided into four specific areas that are: Security, Quality, Delay, and Productivity. These areas will be further explained in the thesis. As previously described, the construction process of the indicators follows a top-down approach. Indeed, the strategy of the organisation in cascaded from the Big Room to the Field tanks to its breakdown is different axes for the Average Rooms and practical objectives for the Field. However, the working of the improvement sheets allows setting a bottom-up information flow since the sheets can be issued from the Field, and can come up to the level of the actors responsible for solving each problem.

4.2.2. Preliminary questions for Performance Measurement implementation

The implementation of the Performance Measurement System at ABC is partly based on the AFNOR (French organization of normalization) recommendations. According to the AFNOR document named “Quality Management System – Indicators and Dashboard”, the definition of an indicator is as followed: “Selected information, associated with a criteria, aiming at observing its evolution at defined intervals”. This standard also recommends answering three main questions before setting indicators: Why setting indicators? Who is responsible for the setting? Who are the customers of the indicators? These questions are then discussed in turn, applying to ABC.

Why setting indicators?

In our case, the setting of performance indicators allows supporting the deployment of the Continuous Improvement approach. According to ABC’s CI objectives, the aim is to get a monitoring structure that allows to:

(1) “Measure in a simple and visual way the performance in order to highlight the encountered problems on the field”
(2) “Analyse these problems in order to be able to build improvement actions with each department”

Who is responsible for the setting?

For all the implemented dashboards, the main actors are the factories or departments managers. They are those who have then been in charge of leading the rituals. Moreover, it belongs to the IMM, which is a transversal department responsible for the deployment of the CI approach, to set the dashboards. The consulting firm helps the IMM for the setting and allows to bring an “external eye”. The part of identification of the indicators has been conducted thanks to several meetings, with the different factories or departments managers.
Who are the indicators customers?

In our case, the customers of indicators of the Big Room are the industrial direction and the factories or departments managers. The customers of the indicators of the Medium Rooms are the factories or departments managers, as well as their management team (workshop manager, foremen, scheduling manager). Finally, the customers of the Totems are the field workers.

The AFNOR document recommends using a descendant approach for the identification of the performance indicators: “knowing before the objectives in order to know what to measure, instead of measuring what is measurable before knowing to what it will be linked”. That is also in this state of mind that the indicators of the different monitoring rooms at ABC have been constructed: the first question was to know what the real needs of the indicators customers were, the second question was about the reliability of the measure.

4.2.3. The global construction principle of the dashboards

According to the French normalization of the indicators and dashboards, a dashboard of indicators is a “monitoring and decision making tool displaying an indicators selection”. In the following part, the construction principle of the indicators dashboards will be presented. Then, some of the implemented dashboards will be described: the dashboards built in the factory Medium Rooms, the construction site Medium Rooms and the Big Room. My internship began with the setting of one factory Medium Room’s dashboard, which constituted a kind of test dashboard. A standard has been defined in this Medium Room. Then, the objective was to extend this standard to the other factories and departments. This practice of the standard had not been always easy because certain factories had their own needs. It was necessary to adapt to the different needs, but always keep in mind to extend the defined standard. Indeed, it is very important to set a consistent standard between the different monitoring rooms in order to ensure that procedures of collecting and using the measures are the same so as to facilitate comparison and data transfer. The setting of the dashboards in the monitoring rooms has followed the standard process illustrated in Figure 9. The numerous mock-ups I did have been very important as communication materials with the different actors and played an important role to convince the future users.

![Figure 9: Standard construction process of the dashboards](image-url)
According to the consulting company which works with ABC, the definition of an indicator is as follows: “Measuring tool which allows knowing the performance level of a workstation, activity, process in order to make it progress. It should be visual, linked to an objective and if it is possible manual”. Therefore, the indicators dashboards have been built in a way to be as visual as possible, with an objective, and most of the implemented indicators are indeed manual. The visual should also have been common between the different factories and departments. In order to ensure the relevance of the indicators dashboards, the SMART method has been used as follows: Significant, Measurable, Accepted, with a person Responsible for, and Timed. When built, every indicator was evaluated and reviewed according to these criteria.

The indicators dashboards have been set with the support of the following matrix, including four columns and three rows.

<table>
<thead>
<tr>
<th></th>
<th>Safety</th>
<th>Quality</th>
<th>Delay</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyse</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Act</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10: Matrix of the implemented dashboards

The standard has been built according to four main performance areas: Safety, Quality, Delay, and Productivity, represented by the four columns of the matrix. These areas are present in each factory and in each department. The three rows of the matrix represent the framework that guides the PMS. As illustrated in Figure 10, for each performance area, the approach Measure→Analyse→Act allows guiding the use of the indicators towards the implementation of improvement actions. The three phases of the approach are now discussed in turn:

Measure

The objective of this part is to visualize a trend on the time scale. These indicators take the form of graphs. Another objective of this part is to rapidly visualize if “we are good or not” according to a goal that has been set. Some colour areas have been used for that (three areas: Red, Orange, and Green). When the actors had no idea about the figured goal to reach, we based the colour areas on the figures of the previous years to set a reference that played the role of the goal in a first step. The measure part aims at displaying the KPIs of the four identified performance areas. The KPIs have been chosen according to the company strategy, broken down through the top-down objectives flow illustrated in Figure 8. Moreover, some brainstorming sessions have been carried out with the different managers in order to prioritize the KPIs to display on the dashboards.
Analyse

The objective of this part is to visualize the causes of indicators which are not in the Green area. The system of “intuitive Pareto” has been often used in order to be able to define and visualize the more frequent causes. The intuitive Pareto consists in writing the encountered causes on each row of a table, and then in making “sticks” on the row at each repetition of the cause. The method of the 5M has been used in order to identify the root causes of the indicators “in the Red”. When the different root causes have been identified thanks to this method, it was also important to let some blank rows so the actors could add some causes gradually when they encounter new causes. Table 11 shows an extract of the intuitive Pareto set in the Big Room for the Safety part.

Table 11: Intuitive Pareto and 5M in Safety analysis

<table>
<thead>
<tr>
<th>Milieu (Environment)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Slippery environment (mud, snow, ice…)</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Environment involving an awkward posture</td>
<td>II</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuitable storage</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Default on the material</td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manufacturing</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuitable handling materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsuitable production / tooling / PPE materials</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Methods</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-formalized operating mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degraded mode (ex: undo to redo, failure, rework of an error…)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Man</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad physical condition to work</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Non-wearing of the PPE suitable for the work done</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Unsuitable behavior</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Act

The Act part constitutes the main objective of the indicators dashboards: setting improvement actions. According to the French normalization: “The goal of the indicators dashboard is to highlight the actions that must be implemented in order to reach the objectives and improve the processes”. Thus, the goal was to define the more accurate root causes in the Analyse part in order to allow taking direct actions resulting from the identification of the most frequent causes.

The following part will present the different dashboards built in the factories Medium Rooms, in the construction site Medium Rooms and in the Big Room. Figure 11 aims at illustrating the focus of these different monitoring rooms regarding the construction process of a building.
4.2.4. The dashboards of the factories “Medium Rooms”

The dashboards of the factories Medium Rooms allow a weekly review about the activity of the previous week and the actions to implement for the coming weeks. Figure 12 thereafter shows the picture of the dashboard built in one of the factories Medium Rooms.

![Dashboard](image)

**Figure 12: One ABC factory Medium Room’s dashboard**

In Figure 12, regarding Safety measurement, it is shown by a cross containing 31 days. This cross allows to visualize the days of the current month where work accidents occurred. Next to the cross, a graphic shows the number of accidents cumulated over the year (with a monthly scale). Orange and red areas allow the comparison with the best year in terms of number of...
accidents. The analysis of safety allows to visualize which parts of the body are impacted by the accidents. Then, the actions are written relatively to the most frequent root causes. Regarding Quality, there is a measurement over the year of the percentage of controlled modules and non-compliances for internal quality, as well as of the number of non-compliances due to the suppliers for external quality (with weekly scales). Then, intuitive Pareto charts allow to identify the root causes. Regarding the Delay, there is a measurement over the year of the percentage of modules delivered on-time, as well as of the percentage of completion on every Monday morning (with weekly scales). The indicator that measures the percentage of modules delivered on-time raised some problems and caused a lot of debates when it was built in the Big Room. Indeed, the different factory managers did not have the same definition of this indicator. This will be detailed in the following part. Regarding the Productivity, there is a measurement over the year of the number of manufactured modules, as well as of the productivity in number of hours spent for a standard module manufacturing.

The dashboards of the other factories Medium Rooms are very similar to the one presented in Figure 12. A few indicators are sometimes a little bit different, for example in one factory; people speak about productivity in hours per square meters (instead of hours per standard modules). Another factory also uses the ratio between man-days (MD) realized and man-days available. The most important thing is that every indicator is in its own place in the matrix and that improvement actions can be driven according to the four main themes.

Table 12 below aims at summarizing the Measure part of the dashboards of the factories Medium Rooms by presenting all the implemented indicators:

<table>
<thead>
<tr>
<th>Safety</th>
<th>Quality</th>
<th>Delay</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>External Quality</strong></td>
<td><strong>Internal Quality</strong></td>
<td><strong>Delay</strong></td>
</tr>
<tr>
<td>- Number of work</td>
<td>- Number of suppliers non-compliances</td>
<td>- % of controlled modules</td>
<td>- Number of manufactured modules</td>
</tr>
<tr>
<td>accidents cumulated over the year</td>
<td></td>
<td>- % of non-compliances</td>
<td>- Number of hours / standard module</td>
</tr>
<tr>
<td>- Number of days</td>
<td>- % of controlled modules</td>
<td>- % of modules delivered on-time</td>
<td>- Number of hours / m²</td>
</tr>
<tr>
<td>without accidents</td>
<td>- % of non-compliances</td>
<td>- % of completion on every Monday morning</td>
<td>- MD realized / MD available</td>
</tr>
</tbody>
</table>
<pre><code>                                                                                                       |                                                   |
</code></pre>
4.2.5. The dashboards of the construction sites “Medium Rooms”

The dashboards of the construction sites Medium Rooms allow a weekly review about the past week activity and actions to implement in the coming weeks. The dashboards of the construction sites Medium Rooms are the last ones that have been implemented. The Safety part is similar to the one of factories Medium Rooms. For Quality part, the idea was to know the number of construction sites having punch items every week. Then, I built an indicator as shown by Figure 13 thereafter.

![Number of construction sites completed during the week](image)

![Number of construction sites with punch items](image)

![% of construction sites without punch items](image)

**Figure 13: Quality indicator of one construction site Medium Room’s dashboard**

The first graphic allows every week to visualize rapidly the number of construction sites completed during the week, as well as the number of construction sites with punch items. As explained in the theoretical part, the punch items are the items that have not been completed or present some defects at the moment of the reception by the customer. Nevertheless, the first graph does not allow to clearly follow a trend and the comparison between two weeks does not appear directly. It is the reason why I created a second graphic representing the percentage of construction sites without punch items in order to visualize a trend. Later, it will also allow to set a goal. The Delay part allows to measure over the year the percentage of construction sites completed on-time (with a weekly scale). Finally, the Productivity part allows to measure the number of square meters by man-days realized on construction site.

Table 13 below aims at summarizing the Measure part of the dashboards of the construction sites Medium Rooms by presenting all the implemented indicators:
4.2.6. The dashboard of the “Big Room”

The dashboard of the Big Room allows a monthly review of the past month activity and the actions to be implemented in the coming months. The Big Room allows to take a step back according to the indicators of the factories and construction site Medium Rooms. Some indicators come from these Medium Rooms and the dashboard of the Big Room contains a few more indicators. Safety part is similar to the Medium Rooms ones. The Quality part is divided in four big families: the suppliers quality with the measurement of the number of supplier non-compliances encountered, the internal quality with the number of non-compliances, the “short term” customer satisfaction just out of the factory with the measurement of the number of the punch items and the actual hours to work on it, and the “long term” customer satisfaction with the measurement in number and in actual hours of the customer service issues. The Delay and Productivity parts are similar to the Medium Rooms ones with indicators that come up directly from the Medium Rooms.

The Big Room allows making work together a lot of members of the company staff: the industrial director, the QSE manager, the factory managers, the production manager, as well as the Purchasing director. It was then necessary to precisely define the person responsible for each indicator as well as when it was needed to fill in the indicator. Therefore, I created a file in order to describe how to fill in the dashboard. I also displayed some “Who” and “When” Post-its on the Big Room wall in order to allow everybody to know well their responsibilities regarding the indicators filling.

Table 13 therefore aims at summarizing the Measure part of the dashboards of the Big Room by presenting all the implemented indicators:

<table>
<thead>
<tr>
<th>Safety</th>
<th>Quality</th>
<th>Delay</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Number of work accidents cumulated over the year</td>
<td>- % of construction sites without punch items</td>
<td>- % of construction sites completed on-time</td>
<td>- Numbers of construction sites completed</td>
</tr>
<tr>
<td>- Number of days without accidents</td>
<td></td>
<td></td>
<td>- m² / MD</td>
</tr>
</tbody>
</table>

Table 13: KPIs of the construction sites Medium Rooms’ dashboard
Table 14: KPIs of the Big Room’s dashboard

<table>
<thead>
<tr>
<th>Safety</th>
<th>Suppliers Quality</th>
<th>Internal Quality</th>
<th>“Short term” Customer satisfaction</th>
<th>“Long term” Customer satisfaction</th>
<th>Delay</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Number of work accidents cumulated over the year</td>
<td>- Number of suppliers non-compliances</td>
<td>- % of controlled modules</td>
<td>- Number of punch items</td>
<td>- Number of customer service operations</td>
<td>- % of modules delivered on-time</td>
<td>- Number of manufactured modules</td>
</tr>
<tr>
<td>- Number of days without accidents</td>
<td>- % of non-compliances</td>
<td>- Number of non-compliances</td>
<td>- Number of hours / punch item</td>
<td>- Number of hours / customer service operations</td>
<td>- % of construction sites completed on-time</td>
<td>- Number of hours / standard module</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tables 12, 13 and 14 aimed at presenting the different indicators implemented in the monitoring rooms are only focused of the Measure part. As previously stated, the PMS at ABC is based on the Measure→Analyse→Act approach. This approach is very important at ABC since it constitutes the framework of the PMS, extended in each monitoring room. It means that for all the presented indicators, the actors are able, after measuring the level of each indicator, to analyse the causes of poor performance and to decide the actions to undertake. It allows to accelerate the decision making process.

4.3. Facilitators for the implementation

During this practical implementation at ABC, I have observed three main kinds of facilitators: committed managers, involved employees and structure of the PMS.

4.3.1. Committed managers

I have been able to observe that performance measurement implementation has been facilitated by committed managers. For example, there was a strong top management commitment in one factory whose the manager was the previous IMM manager. Therefore, he was really committed in the performance measurement approach, which led to a quicker implementation compared to the other factories. It was more difficult with other managers who were more short-term results oriented and were reluctant to give time to performance
measurement since they didn’t see some early benefits: “Measuring is good, but we have also a business to run” (one factory manager).

4.3.2. Involved employees

The second facilitator I observed was a few involved employees in performance measurement. More precisely, there were some employees who already had knowledge or a first experience in performance measurement. Therefore, these employees were really aware of the benefits of such an approach and conscious of the fact that the effort was necessary to get some improvement results. Therefore, they have act as facilitators for the implementation. There was a good example at ABC of a construction site manager who was first in a position of reluctance without seeing the benefits of performance measurement. However, along the implementation, he understood the interest of the approach and its benefits, and even explained them to a construction site worker who was reluctant: “Look, this dashboard has a real value: it will allow us to see where the problems come from, so we can improve”.

On the opposite, the lack of perceived benefits was a real barrier to performance measurement implementation within ABC. For example, here is what the construction site worker answers to the manager: “Yes, but we already know the problems, however no action is undertaken.” This feeling is well spread among the field workers who are confronted to the problems but sometimes do not see any improvement. Besides, the interviews I conducted made me aware that, on the opposite, the employees who felt uninvolved in performance measurement tend to see the dashboards as useless wall-covering, as shows the following remark from a field worker: “That’s nice to have some tapestry there, they [the management team] discuss in front of it ... but I don’t know how it will improve things there for us”.

4.3.3. Structure of the PMS

The structure of the PMS allowed facilitating its implementation. Indeed, the fact that the PMS was divided in three hierarchical levels according to the pyramid on Figure 8 helped people to better understand their role in performance measurement. Moreover, each department had his own indicators dashboard. Therefore, people in each department were able to measure their performance by themselves. In addition, there was a standard existing between the dashboard of the different department, which allowed comparing and using some data between departments.
4.4. **Difficulties encountered during the implementation**

This part aims at presenting the main difficulties I encountered during the implementation of the different dashboards. It is based on observations I made during the implementation, on direct feedbacks from the people involved during the meetings, as well as on unstructured interviews at different hierarchical levels.

4.4.1. **Time and effort required**

I have been faced to the problem of availability of the employees for performance measurement. For example, the customer service manager in one factory told me: “Measurement is good, but I have really no time to do it and when I do it, it comes in addition, and after I completed my work. For example, I’ll be able to treat the measures of customer services operations of January only in March, there will always be at least two months delay. We need resources to do measurement in time.” Time and effort required was also the most cited difficulty regarding the unstructured interviews I conducted at ABC.

4.4.2. **Finding appropriate measures**

The second main difficulty I encountered during the implementation dealt with finding appropriate measures. These difficulties deal with the time scales, the factories Delay indicators, the suppliers Quality indicator, the “long term” customer satisfaction, and the construction site Productivity indicator. There are now discussed in turn.

**The time scales**

The definition of the time scales has sometimes raised some problems. At the beginning, all the time scales were in weeks. During the first rituals of the Big Room, the factory managers put forward the idea of having monthly scales since this was simpler for them for collecting the data. However, the member of the consulting firm argued that "what is weekly driven evolves on a monthly basis and what is monthly driven evolves on a yearly basis". It is the reason why it was necessary to try to have weekly measurements when possible. This issue underlines the cost of the data collection needed in order to have an efficient PMS.

**The factories Delay indicator**

The construction of the factories Medium Rooms indicators allowed to highlight the use of different definitions of the delay indicator. Indeed, many questions were raised: Do we have to consider the delay until the modules reception by the customer or the delay until the
modules are released by the factory? Do we have to consider the modules stored in the park? Finally, the chosen definition accepted by everyone was this one:

⇒ Percentage of modules delivered without any delay due to production (except park storage)

This issue underlines the need of finding appropriate measures that are understood and accepted by everyone.

**The suppliers Quality indicator**

The construction of the suppliers quality indicator allowed to highlight some discrepancies for the Big Room’s dashboard. Indeed, the different factories had created a file to follow up the non-compliances using a range of families to classify these non-compliances. Nevertheless, the Purchasing department was not aware of this file and was using a different range of families. Therefore, a meeting was organized in order to redefine a new range of families, so that everyone can use the same. The file was then updated and I took advantage of the occasion to integrate directly the indicators scoreboards into the Excel file, with as a measurement the number of issued and closed non-compliances and as an analysis the families re-defined at the meeting. The indicators are directly issued from the follow-up file. The indicators are updated as soon as the users add a new line into the follow-up file. Therefore, this example shows how the implementation of the PMS at ABC allows to correct the discrepancy regarding the treatment of the suppliers’ non-compliances. Moreover, this issue has also led to implement an automated indicator.

**The “long term” customer satisfaction**

For the measurements of customer service issues and punch list, we have finally chosen measurements expressed in number of occurrences and in number of hours. At the beginning, there was only a measurement in number of occurrences. When I presented this indicator to the customer service manager, he said: “the number of customer service issues is not representative at all of the reality: I prefer to have 10 issues of 2 hours each, rather than 5 issues of 10 hours each. Yes, because my employees have less to do with 10 issues of 2 hours each”. Indeed, the workload is lower in the first case. However, 10 issues make 10 unsatisfied customers, whereas 5 issues make only 5 unsatisfied customers, even if the operations to execute are longer. Therefore, we decided to keep the measurements both in number of occurrences and in number of hours and we understood we were facing two different measurements: the number of occurrences allows to give an information about the non-quality of the process, and the number of hours allows to give an information about the cost of non-quality (time spent to realize the customer service operations). It is even a little more complex in the way that, in addition of the cost for the company, the time spent for customer service issues also affects customer satisfaction. In any case, these two measurements are
complementary and both are displayed in the Big Room. This issue underlines the need to build appropriate measures that represent at the best the work of the employees.

**The construction site Productivity indicator**

The construction site Productivity measurement part is rather complex, as the graphics of the Measure are not as straightforward as for the factories Productivity. It comes from the diversity of cases encountered on construction sites which are continuously varying and there is nothing to measure the complexity like in the factories. For this reason, the definition of a goal and the analysis phases are very difficult. Several possible actions have been identified in order to solve this problem. A "(Time spent for the case on construction site / Total time spent for the case)" indicator has been tested, it allows to "neutralize" the differences of complexity, but it was not straightforward enough and too costly for data collection. So, the construction site manager tried to categorize the construction sites. He created four different categories on which we were able to measure the productivity in square meters by man-days. The problem is that these four graphics do not allow to visualize if “you are good or not at a global level”. The solution was then to realize a global graphic with a variable goal weighted by the number of modules manufactured in each category. This solution has not been validated by the users who thought that the concept of variable goal could have been hard to understand for everyone. The last solution was to set a goal by intuition. Indeed, in order to forecast the number of employees to provide for a construction site, the construction site manager estimates a complexity. The idea is then to compare the estimated time to the actual time (in hours). The estimated time is used as the goal. The second stage is to define a complexity table in order to "assess" the intuitions of the construction site manager for setting the goal. This last solution was adopted for one of the construction sites Medium Rooms.

4.4.3. **Analysis phases in general**

The analysis of Delay and Productivity parts has been quite difficult to implement. It was particularly difficult to determine the root causes in advance in order to be able to register them each time they occur. Indeed, the causes for missed delays or productivity decrease can be very variable. Consequently, the idea was in a first time to simply register the individual causes as soon as they were spotted by the actors. This allowed to have a database of potential causes which can be then discussed during the rituals. A rather efficient technique to identify the root causes was the "5 Whys" approach. This technique consists of repeating the question several times in succession in order to determine the root cause. It was particularly used for customer quality analysis where several levels have been identified: the symptom (example: a water leak), the reference point (example: a defect in the carpentry) and the cause (example: no seal in place). As soon as the cause is identified, the goal is to look for the real root cause (example: the construction site workers had no more seals on the truck. Why? → Nobody
checked the materials before to go). This example led to implement some check-lists to fill before the departure of the trucks towards the construction sites.

4.4.4. The reluctance for measurement

According to the consulting company, a Continuous Improvement approach consists in: “20% of tools and 80% of cultural approach”. Regarding this cultural part, I have been faced with difficulties regarding the acceptance of measurement. Indeed, I have seen that unfortunately, the monitoring tools are sometimes seen as “police” tools. This is directly linked to the company culture of ABC. The employees tend to dread the managers behaviours regarding the use the indicators. For example, the sales representatives were reluctant to implement a measure aimed at improving how they prioritize and manage all their customer offers. They argued that the sales manager would use these measures to look for the people responsible for late files.

Therefore, the consulting company works a lot on the managerial posture by trying to show the interest of preferring improvement and analysis behaviours rather than accusation and justification behaviours. During this implementation, I understood that in order to overcome the difficulties of reluctance, it was really important to give sense to the approach of all the involved actors so they are able to appropriate the measures. Furthermore, it is sometimes important to wait for the actors to be ready for the implementation, and come back to them later. It is also important that most of the ideas come from the actors during the meetings since it leads to a higher level of motivation.
5. Analysis

This chapter aims at conducting a theoretical verification by comparing the literature review with the results of the case study. This verification deals with KPI identification, PMS design, and its practical implementation considering main key success factors, barriers and issues.

In this Analysis chapter, theoretical verification will be performed based on the comparison between theories from the literature review and empirical results from the case study. The theoretical verification is conducted regarding KPI identification, PMS design, and PMS practical implementation.

5.1. KPI identification

Table 15 below aims at summarizing the main KPIs identified in the different monitoring rooms of the case study.

**Table 15: KPIs of all the monitoring rooms discussed in the case study**

<table>
<thead>
<tr>
<th>Safety</th>
<th>Suppliers Quality</th>
<th>Internal Quality</th>
<th>“Short term” Customer satisfaction</th>
<th>“Long term” Customer satisfaction</th>
<th>Delay</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Suppliers Quality</td>
<td>Internal Quality</td>
<td>“Short term” Customer satisfaction</td>
<td>“Long term” Customer satisfaction</td>
<td>Delay</td>
<td>Productivity</td>
</tr>
<tr>
<td>Number of work accidents cumulated over the year</td>
<td>Number of suppliers non-compliances</td>
<td>% of controlled modules</td>
<td>Number of punch items</td>
<td>Number of customer service operations</td>
<td>Number of modules delivered on-time</td>
<td>Number of manufactured modules</td>
</tr>
<tr>
<td>Number of days without accidents</td>
<td>% of non-compliances</td>
<td>Number of hours / punch item</td>
<td>- % of construction sites without punch items</td>
<td>- % of completion on every Monday morning</td>
<td>% of construction sites completed on-time</td>
<td>Number of hours / standard module</td>
</tr>
<tr>
<td>- Number of work accidents cumulated over the year</td>
<td>- Number of suppliers non-compliances</td>
<td>- % of controlled modules</td>
<td>- Number of punch items</td>
<td>- Number of customer service operations</td>
<td>- Number of modules delivered on-time</td>
<td>- Number of hours / standard module</td>
</tr>
<tr>
<td>- Number of days without accidents</td>
<td>- % of non-compliances</td>
<td>- Number of hours / punch item</td>
<td>- % of construction sites without punch items</td>
<td>- % of completion on every Monday morning</td>
<td>- % of construction sites completed on-time</td>
<td>- Number of hours / m²</td>
</tr>
<tr>
<td>- Number of work accidents cumulated over the year</td>
<td>- Number of suppliers non-compliances</td>
<td>- % of controlled modules</td>
<td>- Number of punch items</td>
<td>- Number of customer service operations</td>
<td>- Number of modules delivered on-time</td>
<td>- Number of hours / MD</td>
</tr>
<tr>
<td>- Number of days without accidents</td>
<td>- % of non-compliances</td>
<td>- Number of hours / punch item</td>
<td>- % of construction sites without punch items</td>
<td>- % of completion on every Monday morning</td>
<td>- % of construction sites completed on-time</td>
<td>- MD realized / MD available</td>
</tr>
</tbody>
</table>
The above table is actually based on Table 14 describing the KPIs of the Big Room. Indeed, only the indicators written in brown come from other monitoring rooms: “% of construction sites without punch items” in Quality comes from the construction sites Medium Rooms, “% of completion on every Monday morning” in Delay and “MD realized / MD available” in Productivity come from the factories Medium Rooms. These three KPIs do not appear in the Big Room’s dashboard since they are more practically oriented and aims at managing performance only within factories and construction sites.

As shown in Table 9 and 10 of the literature review, Cox et al. (2003) developed a set of quantitative and qualitative KPIs for construction industry. Table 16 thereafter aims at identifying if these KPIs are whether or not used in the different monitoring rooms’ dashboards of the case study according to the indicators displayed in Table 15.

**Table 16: Use of the literature’s construction KPIs in the case study**

<table>
<thead>
<tr>
<th>KPIs from the literature (Cox et al. 2003)</th>
<th>Used in the case study</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantitative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units / MH</td>
<td>Yes</td>
<td>- m² / MD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Number of manufactured modules</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Number of hours / standard module</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Number of hours / m²</td>
</tr>
<tr>
<td>$ / Unit</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>On-Time Completion</td>
<td>Yes</td>
<td>- % of modules delivered on-time</td>
</tr>
<tr>
<td>Resource Management</td>
<td>No</td>
<td>- % construction sites completed on-time</td>
</tr>
<tr>
<td>Quality Control and Rework</td>
<td>Yes</td>
<td>- % of controlled modules</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- % of non-compliances</td>
</tr>
<tr>
<td>Percent complete</td>
<td>Yes</td>
<td>- % of completion on every Monday morning</td>
</tr>
<tr>
<td>Earned MH</td>
<td>Yes</td>
<td>- MD realized / MD available</td>
</tr>
<tr>
<td>Lost Time Accounting</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Punch List</td>
<td>Yes</td>
<td>- Number of punch items</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Number of hours / punch item</td>
</tr>
<tr>
<td><strong>Qualitative</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>Yes</td>
<td>- Number of work accidents cumulated over the year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Number of days without accidents</td>
</tr>
<tr>
<td>Turnover</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Absenteeism</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
The blue items in Table 16 are the KPIs that Cox et al. (2003) qualified as the most significant for the current practitioners. Regarding the measure of Productivity, the literature uses the indicator of “Units/MH”. It is not this exact measure in the case study, but it is really close to the measure of “m²/MD”. Several other similar indicators are used in ABC’s dashboards such as the number of manufactured modules (which can be considered as “units”), the number of hours per standard module, and the number of hours per m². However, according to the table, all the measures regarding the cost of construction ($/Unit, Cost and Resource Management) do not appear in the ABC’s dashboards. Indeed, even if all these items are measured at ABC, they are not displayed in the existing monitoring rooms.

Moreover, the indicator “Lost Time Accounting” dealing with the waste hours does not appear neither. This indicator is indeed really hard to measure in a holistic view of the organisation. However, it has been measured at local scales, for example in order to optimize some work stations of ABC factories. Regarding Qualitative measures, only the measures of Safety are used in ABC’s dashboards. Turnover and absenteeism are measured within the organisation but not displayed in any dashboard. Motivation is not measured at ABC.

On the opposite, as shown on Table 17, two main Quality performance areas from ABC’s dashboards are not discussed in the Cox et al. (2003) article. They are the Suppliers Quality and the “Long term” Customer satisfaction.

<table>
<thead>
<tr>
<th>Performance areas of ABC’s dashboards</th>
<th>Safety</th>
<th>Suppliers Quality</th>
<th>Internal Quality</th>
<th>“Short term” Customer satisfaction</th>
<th>“Long term” Customer satisfaction</th>
<th>Delay</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussed in the literature (Cox et al. 2003)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

These two big differences can come from the particularities of modular construction. Indeed, modular construction relies more on suppliers than traditional construction. Modular construction companies receive for example some pre-assembled pieces that take place in the factories and which need to be managed with a real inventory strategy. Then, the “Long term” Customer satisfaction should also been more common in modular construction whose companies conduct more customer service operations than in traditional construction. As presented in the literature review, performance measurement should offer a balanced view of performance. Thus, it is important to try to answer the following question:
Do the implemented indicators at ABC constitute a balanced view of performance?

Table 17 shows that ABC’s indicators cover several areas of performance which are as discussed in the case study: Safety, Quality, Delay and Productivity. Moreover, the Quality area offers a balanced set of quality indicators covering the quality of all the steps of a construction process as illustrated in Figure 14.

![Figure 14: Measure of the Quality regarding a construction process](image)

As illustrated in Figure 14, the phase of the modules transportation belongs both to the internal quality and the short term customer satisfaction. Indeed, as presented in the case study part, the preparation of the trucks in the factory is really important. Besides, if there are some forgotten or non-compliant parts, it could lead to punch items that will affect customer satisfaction at the reception of the building.

Nevertheless, as discussed before, there is no display of financial measures in ABC’s dashboards. Therefore, I would argue that the implemented indicators at ABC offer a balanced view of the performance, but contain a lack of financial measures. It is interesting to see that, as explained in the literature review, the first performance measurement models were criticized because they were only financially driven and that these measures do not appear in the case study. Therefore, this issue raises another question:

**Why financial indicators are not displayed in ABC’s dashboards although they are measured?**

According to ABC managers, financial measures will not help to conduct improvement actions on the identified problems according to the Measure→Analyse→Act approach. Then, a few also told me that some of the financial measures are not designed for everybody and that it is better to keep some measures on a computer screen, just for the people involved.

According to the literature review, there is a last question that can be asked regarding the KPI identification:
Are the implemented KPIs at ABC lagging or leading measures?

As presented in the literature review, Beatham et al. (2004) argued that only KPIs related to people results, safety and client satisfaction offer the opportunity to change (see 3.7.). However, I would say that all the implemented indicators in ABC’s dashboards are leading measures since the approach Measure→Analyse→Act aims at enabling people to use the measures of previous activity so as to predict future performance and take decisions. In addition, as presented in the case study part, when the actors had no idea of the goal to reach for an indicator, we took the figures of the previous year. This practice is supported in the literature review considering that knowing past performance gives a reference point to measure future performance (Alfred, 1988).

5.2. PMS design

First, there are similarities between the Measure→Analyse→Act approach implemented at ABC and the Deming cycle. Indeed, the “Plan” phase can be considered as equivalent to the strategy definition, KPI identification, and the PM procedures definition. The “Do” phase can deal with collecting the data and measuring. The “Check” phase can be seen as an analysing phase and finally, the “Act” phase deals with the implementation of improvement action. Furthermore, it is very important to note that the Measure→Analyse→Act approach implemented at ABC is also a cyclic approach in the sense that the impact of the improvement actions will be measured. Therefore, it is like a measuring phase comes again every time after an improvement phase.

This approach can also be compared to the PMS development model of Bourne et al. (2000). Figure 15 thereafter shows how the implemented PM approach at ABC can match in their model. Indeed, the implemented PM approach is almost there in the phase called “Use of measures to assess the implementation of strategy”. Indeed Measure→Review→Act is similar to the dashboards’ framework if I can consider that “Review” means “Analyse”.
As explained in the literature review (see 3.3), there are several review loops in the PMS development model of Bourne et al. (2000). It is time to deal with the review loops and the change management of PMS at ABC. During this period of implementation, there was no real review system implemented. When the dashboards were in the phase of use, we went regularly through them and we met the different users in order to get some feedback. However, this informal review will be further transformed in a real review system. As previously stated, the implementation of the indicators dashboards at ABC are based on the AFNOR document which recommends also conducting a periodic review of the PMS when it is implemented. The standard especially recommends assessing:

(a) The relevance of the indicators
(b) The cost of data collection
(c) The users satisfaction
(d) The relevance according to the strategy

Figure 15: Comparison of Bourne et al. (2000) PMS development framework with the implemented PM approach
Table 18: Comparison between AFNOR recommendations and Bourne et al. (2000) framework regarding review loops in PM

<table>
<thead>
<tr>
<th>AFNOR recommendations</th>
<th>Bourne et al. (2000) framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) The relevance of the indicators</td>
<td>(1) Reviewing targets</td>
</tr>
<tr>
<td></td>
<td>(2) Developing measures</td>
</tr>
<tr>
<td></td>
<td>(3) Reviewing measures</td>
</tr>
<tr>
<td>(b) The cost of data collection</td>
<td></td>
</tr>
<tr>
<td>(c) The users satisfaction</td>
<td></td>
</tr>
<tr>
<td>(d) The relevance according to the strategy</td>
<td>(4) Challenging strategy</td>
</tr>
</tbody>
</table>

The (a) AFNOR recommendation deals with the review of the operational goals and the warning levels of the indicators measures as well as the characteristics and dimension of the measures. Therefore, as illustrated in Table 18, it can be considered that the item (a) groups the review loops (1), (2) and (3) of the model in Figure 15. Then, (d) is equivalent to the loop (4) regarding the review of the strategy. However, the items (b) and (c) regarding the evaluation of the data collection cost and users satisfaction are not discussed in the model in Figure 15. I think that (b) is more relevant during this period of implementation since when the PMS is well settled; people already know the cost of data collection and there is no reason to review it as long as the procurement ways do not change. However, I think that according to the item (c), it is interesting to review the users’ satisfaction of the indicators by conducting some periodic interviews. Therefore, even if I stated before that there was no measure of employees motivation at ABC, the measure of the users’ satisfaction could lead to give an incentive on the motivation of the employees regarding performance measurement.

Figure 16 below aims at showing the working of the PM approach implemented at ABC by displaying two main loops: a “use” loop in white and a “review loop” in yellow. As previously stated, the Measure→Analyse→Act approach can be seen as a cycle, represented in Figure 16 by the white arrow, included in a bigger cycle represented by the yellow arrow. The white arrow represents the fact that every improvement actions should, if it is successful, change the value of the measures, which will need new analysis and then again actions on the potential non-performance causes identified. Thereafter, the yellow arrow, more oriented in the long term, represents the review loop of the PMS.
Based on Figure 8 and 16, an “improved” PMS for ABC can be built, showed in Figure 18, containing the two main performance measurement cycles. The Measure→Analyze→Act approach can be seen as a cycle, represented by the white arrow, as explained with Figure 16. Then, it is possible to add a review loop, represented by the yellow arrow, for each dashboard, regarding the four recommendations of the AFNOR standard. The top-down objective flow of Figure 8 is also represented by the black arrows.

**Figure 16: ABC PM approach displaying the two different PM cycles**

**Figure 17: “Improved” ABC PMS displaying the two different PM cycles**
It is possible to compare Figure 16 and Figure 17 to the framework described by Sallum and Myrelid (2012) (see 3.5) where they developed a process-based framework divided in a top-down and in a bottom-up approach. They recommended that the top-down approach should ensure that strategy is reviewed, for example by using target letters. In Figure 17, this top-down approach is represented by the black arrows which show how the objective flow is cascaded from the top management to the field. Moreover, the authors recommend that the bottom-up approach allows the employees to ask for the good questions. In Figure 17, this is illustrated by the yellow “dashboard review loop” which allows ABC employees to link the measures to the strategy as well as to challenge some strategic assumptions.

5.3. PMS implementation

This part of the theoretical verification deals with the practical implementation of a PMS according to the main key success factors, the barriers and some performance measurement issues.

5.3.1. Key success factors

Perceived benefits of performance measurement

This factor is verified in the case study considering the results of the unstructured interviews conducted at ABC. Indeed, the example about involved employees at ABC (see 4.3.2.) showed how the insight of benefits helped to implement performance measurement within ABC. Moreover, this example showed that people who were reluctant to performance measurement at ABC argued that they didn’t see the benefits of measurement. Indeed, some field workers did not see any benefits of performance measurement since they thought it will just reveal things that they already know. Sometimes, they see the absence of actions undertaken as unwillingness from the top management. If it could be sometimes a reason of non-action, another reason can come from the fact that top management has sometimes not the same understanding of the problems than the field workers. Therefore, the dashboards can allow the manager to get a better understanding by really visualizing the problems. This issue aims at verifying the literature regarding the fact that top management commitment is really important at all the steps of performance measurement: from the identification of the KPIs to the implementation of improvement actions (Bourne et al., 2002)
Continued top management commitment

![Image of Dilbert comic strip showing top management commitment](image.png)

**Figure 18**: Dilbert and the management commitment in PM (Adams, S., 2006)

Top management commitment particularly means that the managers must be present as a support for implementation of performance measurement and Figure 18 shows a typical behaviour of a non-committed manager for performance measurement implementation. The importance of top management commitment is verified in the case study. Indeed, I have seen some real differences regarding the top management commitment in the three factories, and noticed that it played a really important role for the success of the implementation (see 4.3.1.). On the opposite, I have also been faced to other managers’ behaviours that verify a point of the literature review dealing with the fact that managers tend to be more interested in short term results (Bourne et al., 2000; Lantelme and Formoso, 1999), and by the fact do not fully involve in the performance measurement approach.

**Worth effort**

I have also noticed during the implementation at ABC that the perceived benefits, the worth effort and the continued top management commitment are linked together and that the management role is important to make the trade-off between effort and benefits. Indeed, as stated in the case study (see 4.3.1), the strong top management commitment existing in one ABC factory allowed the employees to really understand that performance worth the effort required. In order to succeed, this factory manager often used the strength of example. Each time performance measurement led to a successful improvement action, he presented it to the employees in order to make them aware that the effort they put in performance measurement gave its results. This process allows particularly to avoid the issue discussed before considering that some field workers didn’t perceive PM benefits since they didn’t see any improvement actions on problems they already know. This is a real issue of motivation and this example allows to verify a recommendation from Lantelme and Formoso (1999) who argued that the cycle time to provide information of measurement must be reduced so as to increase motivation. This issue also verifies the recommendation from Hudson et al. (2001) for using some iterative processes in order to maintain the “momentum and enthusiasm of the development team”.
Structured framework

As stated in the literature review, a structure framework is a key success factor for the implementation since it enables employees to use the measures in their daily work (Lantelme and Formoso, 1999). As stated in the case study, performance measurement implementation within ABC has been facilitated by the support of a structured framework (see 4.3.3.). This framework is structured according to two main components. First the PMS design presented in Figure 8 is really important in order to divide performance measurement in several monitoring rooms at different hierarchical levels. Secondly, the Measure→Analyse→Act approach aims at guiding the use of the KPIs to the implementation of actions in order to improve performance. As presented in the case study part, it was also very important that this standard approach was commonly used within the whole organisation in order to ensure the validity of the procurement and use of the data so as to enable transfer and comparison of measures. For example, as presented in the case study, the implementation of the supplier Quality indicator aimed at standardizing the practices to deal with the measures of the non-compliances (see 4.4.3.). Moreover, as stated in 5.2., a structured system is really important to be able to conducted changes and to review how performance measurement is conducted.

Link to the strategy

Figure 17 before aimed at illustrating how the organisation strategy is broken down in the Medium Rooms’ dashboard and in the Field. According to the practical implementation at ABC, I am not able to verify if the link to the strategy is a real key success factor for the implementation phase. However the link seems to be important for the utilization phase to ensure that performance measurement is consistent regarding the whole organisation.

Employee involvement

The employee involvement was a key success factor for the performance measurement implementation within ABC. The following example from the case study: “That’s nice to have some tapestry there, they [the management team] discuss in front of it ... but I don’t know how it will improve things there for us” shows that employee investment is really linked to the perceived benefits of performance measurement (see 4.3.2.). It has to be carefully explained by the managers. Furthermore, the previous remark raises another issue: the worker saw the dashboard like a “tapestry” because nobody explained him. Actually, the dashboard was one of the factories Medium Rooms but not displayed in an actual room due to space issues. Therefore, it was logical that the dashboard had not been explained to the field workers since it was not designed for them. Indeed, as presented in the case study, the information for the Field in supported by the Totems. This issue shows that, either the indicators are aimed to a group of people and thus they need to be carefully explained, or the indicators are not aimed
to this group of people, and there is no reason for showing them, in order to avoid some potential misunderstandings.

In the literature review, Boussard (2001) showed the existence of “pregnant indicators” to which the employees give their interest because they think they represent their activity in the best way. This is verified in the case study by the example of the customer service manager for whom his activity was represented by the number of hours of customer service issues and for whom the number of occurrences had no real signification. This indicator can be considered as “pregnant” for him and he will be therefore able to justify his involvement in the evolution of the indicator.

**Benchmarking**

As presented in the literature review, Benchmarking is the key in order to set the targets of the indicators (Beatham *et al*., 2004; Lantelme and Formoso, 1999). As stated in the literature review, most of the construction companies did not use Benchmarking and measure performance only for an internal purpose (McGeorge and Palmer, 1997). Indeed, at ABC, the measures are only used for the performance management inside the company and not for Benchmarking. More precisely, only *internal* Benchmarking was used at ABC (i.e. between several departments or factories) but Benchmarking against competitors was never used. Moreover, I grew aware that there was a strong competition spirit between the different modular construction companies. Indeed, there were for example strong confidentiality issues and lots of efforts are put in patents appliances and in the protection of the product innovation ideas. These strong competition and confidentiality issues makes really difficult to exchange information on performance and I do think that this is the main reasons that lead companies to only benchmark themselves, which according to the literature review offers the least opportunity for improvement (McGeorge and Palmer, 1997).

**Simplification of the measures**

As stated in the literature review, most of the authors agreed that simplification of the measures was a key success factor (Lantelme and Formoso, 1999; Neely *et al*., 1997). However, Berry (1983) pointed out the fact that this reduction of complexity leads indicators to give some “abbreviations of the truth” and “abbreviations of the good” that constitute shortcuts and lead to a “decisions automation” allowing to save time, but also to skew the decisions makings. The author particularly argues that every management situation has a complexity that exceeds the analysis capacity of human beings. This level of complexity is illustrated in the case study regarding the implementation of the construction site Productivity indicator. In this case, we faced a real difficulty to find measures that were both relevant and simple to understand. It shows that a trade-off must be found between reality representation and understanding by the people involved.
Table 19 thereafter aims at summarising the results of the key success factors verification.

Table 19: Verification of key success factors

<table>
<thead>
<tr>
<th>Key success factors from the literature review</th>
<th>Verified factors in the case study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived benefits of performance measurement</td>
<td>Yes</td>
</tr>
<tr>
<td>Continued top management commitment</td>
<td>Yes</td>
</tr>
<tr>
<td>Worth effort</td>
<td>Yes</td>
</tr>
<tr>
<td>Structured framework</td>
<td>Yes</td>
</tr>
<tr>
<td>Link to the strategy</td>
<td>No</td>
</tr>
<tr>
<td>Employee involvement</td>
<td>Yes</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>No</td>
</tr>
<tr>
<td>Simplification of the measures</td>
<td>Not really</td>
</tr>
</tbody>
</table>

As illustrated in Table 19, there are two key success factors from the literature review that have not been verified with the case study, these are: link to the strategy and benchmarking. As previously explained, it does not mean that the case study showed that these two factors are not key success factors; it is just that it has not been able to verify those ones within the case study. Regarding the simplification of the measures, the case study revealed that this factor is not as simple and that a trade-off has to be found. This last issue will be discussed in the next part. Moreover, there was no additional key success factor identified in the case study compared to the literature review.

5.3.2. Barriers

Time and effort required

Similarly to the study of Bourne et al. (2002), “time and effort” required was the most cited reason in the interviews I conducted. The following remark from 4.4.1 reveals several things. “Measurement is good, but I have really no time to do it and when I do it, it comes in addition, and after I completed my work. For example, I’ll be able to treat the measures of customer services operations of January only in March, there will always be at least two months delay. We need resources to do measurement in time”. First, it verifies that the time and effort required is a main barrier for performance measurement. Then, it important to
notice that measurement does not seem to be part of the “real” work of the customer service manager since it “comes in addition”. This issue brings an illustration of the performance measurement dilemma discussed in the literature review and presented by Bourne (2008) as: “how do we manage today whilst preparing for tomorrow?” According to the presentation of the research question (see 1.2.), I stated that performance measurement implementation is considered as successful “when management teams use the majority of the measures in the management of their business” (Bourne et al., 2002). According to the previous example of the customer service manager, the performance measurement implementation cannot be said as fully successful since he will not be able to use correctly the measures in his business due to the delay in data collection. Therefore, I think it could be interesting to consider data collection as a real part of the management business and not as something which comes in addition. This assumption considering performance measurement needs time to spread in the organisation, and it will be discussed in the following part that it can be supported by organisational learning.

Human behaviour

![Figure 19: Dilbert and the human behaviour with PM (Adams, S., 2002)](image)

Human behaviour is really important to consider when implementing performance measurement. Figure 19 shows how people can interpret the measures in order to judge and compare people worth. According to the literature review, Lantelme and Formoso (1999) argued that some managers, when analysing the results, tend to look mainly for “who or what is to blame for the existing problems instead of focusing on process improvement”. I have seen that this issue is very important at ABC and it can lead to reluctance for measurement at ABC. Indeed, as described in the case study part, it leads some ABC employees to see measurement as “police” tools aiming at looking for the people responsible for poor performance.
Data access

The difficulty for the data access was often cited as a barrier in the unstructured interviews I conducted within ABC. According to the literature review, this difficulty can come from technical or organisational issues. As stated in 3.4.2., it can come from inappropriate IT systems, lack of people and time, and human behaviour. Regarding the case study at ABC, I have mostly been confronted to technical difficulties to access the data. For example, it was quite difficult to measure manufacturing times in the field due to the construction process of modular construction, which makes different people working together at the same time. Therefore, it was particularly hard to breakdown the elements of the production process to a measurable scale. Moreover, the issue discussed in the case study dealing with the difficulty encountered to choose the time scales shows that the cost of data collection must be considered when choosing measures. It particularly shows that there is a trade-off between accurate data and cost of measurement.

Finding appropriate measures

As presented in the literature, finding appropriate measures is an unescapable barrier that has to be overcome (see 3.4.2.). Moreover, this process needs time (Kaplan and Norton, 2004). I have been confronted to this issue during the practical implementation at ABC (see 4.4.2.). I have made countless of mock-ups so as to find measures more and more appropriate each time. For example, the difficulties presented in the case study part dealing with the definition the factories Delay indicator and the construction site Productivity indicator show that finding appropriate measures is a complex problem that needs time as well as feedbacks from all the involved actors. These difficulties for finding appropriate measures within the case study can allow verifying the particularities of construction industry described by Lantelme and Formoso (1999) regarding the uniqueness and the complexity of construction projects.

Employee skills

Finally, the lack of employee skills identified in the literature as a barrier for performance measurement implementation can be verified in the case study by the fact that the company called a consulting firm to support the implementation because they perceived that they had a lack of skills in this matter. This call to the consulting firm has to be interpreted by its operational role, but also by its anxiolytic role (Berry, 1983). Indeed, the more and more changing and competitive environment leads people to call for consultants in order to ensure that their organisation working is still relevant. According to Berry (1983), it also explains the following strong contradiction: “although everybody justifies the uniqueness of the situations they encountered, everybody seems reassured by implementing some models at universal vocation”. That is the reason why organisational learning is really important in the matter of performance measurement in order to enable people to develop an appropriate and “home-made” PMS which really fits the particularities of the organisation.
Table 20 thereafter aims at summarising the results of the key success factors verification.

Table 20: Verification of barriers

<table>
<thead>
<tr>
<th>Barriers from the literature review</th>
<th>Verified in the case study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time and effort required</td>
<td>Yes</td>
</tr>
<tr>
<td>Human behaviour</td>
<td>Yes</td>
</tr>
<tr>
<td>Data access</td>
<td>Yes</td>
</tr>
<tr>
<td>Finding appropriate measures</td>
<td>Yes</td>
</tr>
<tr>
<td>Employee skills</td>
<td>Yes</td>
</tr>
</tbody>
</table>

As illustrated in Table 20, all the barriers from the literature review have been verified in the case study. Also, there is no additional barrier found in the case study.

5.3.3. Performance Measurement issues

Manual versus Automated measures

The literature recommends automating the data collection in order to reduce the cycle time to provide information of performance measurement (Lantelme and Formoso, 1999). They also showed that it allows making some visual formats easily accessible by anyone in the organization. At ABC, almost all the measures are collected automatically. However, regarding the indicators dashboards in the monitoring rooms, except the supplier Quality indicator, the measures are displayed in a manual way on the dashboards. I grew aware within ABC that manual indicators are more interactive and constitute a better support to communicate during the meetings. Moreover, if a computerized indicator is, in theory, accessible by anyone, the risk is that few people will look at the file, whereas manual indicators can really be seen by anyone. In addition, some manual data collections may help in the first steps of a performance measurement approach. In the Bourne et al. (2002) case study, one company succeeded in overcoming the barrier of the data access by a manual collection of the data. Nonetheless, automated measurement has a clear advantage against manual indicators for the storage of the information. At ABC, most of the dashboards keep the information over a one year period. But it could be interesting to keep some information from one year to the other, for example regarding the different identified root causes that can serve to compare analysis from one year to another. That is the reason why a computerized storage could be conducted at ABC, for example once a year in order to keep the important information.
Local approaches and global consistency

We have seen in the literature review that Berry (1983) argued that local performance measurement approaches do not always lead to an organisation-wide performance improvement. This warning shows the importance of the top-down objectives approach implemented at ABC and illustrated in Figures 8 and 17. This also brings forward the importance that must play the Big Room which should ensure that the juxtaposition of different local logics allow the reliable working of the organization. Furthermore, the global consistency within ABC is sustained by ensuring that a real standard is extended in all the monitoring rooms of the organisation.

Organisational learning

In order to overcome these limits of local logics and rationality previously discussed, it is important to put into perspective the ability of the indicators to describe the real world and to explain their limits and significations. That is the reason why at ABC, I think that the rituals should be some places where the indicators are used, but the rituals must also constitute a space for dialogue about the relevance of the implemented indicators. Indeed, I have seen some changes in behaviour regarding the benefits of performance measurement (e.g. construction site manager discussed at the beginning of the part 5.3.1.) by the means of these spaces for dialogue that constitute the rituals. This verifies a recommendation from Lantelme and Formoso (1999) regarding the need of settling “moments for reflection”. Therefore, the different difficulties encountered during the implementation can allow the organisation to learn. Indeed, at ABC, performance measurement led for example to the implementation of quality check-lists to fill in before the truck departure to the construction site. This example at ABC shows how performance measurement can support organisational learning. On the opposite, organisational learning is also essential to support a performance measurement approach. Indeed, the company needs to learn how to improve its learning capability so as to implement an effective PMS. This is illustrated in the case study by the importance of developing system thinking for the analysis and the research of the root causes. For example, at ABC, the use of the “5 Whys” for the Analysis of non-performance to support the implementation of the suppliers Quality indicator for the Big Room led to identify inconsistent practices regarding the measurement of the non-compliances. The implementation has then allowed to correct the inconsistency and to make everyone aware of the new standard practice to deal with the measurement of the suppliers non-compliances. Therefore, it is possible to see a double support linkage between performance measurement and organisation learning, as illustrated in Figure 20.
According to the literature review (see 3.6.4), the theory distinguished the single-loop leaning and the double loop learning. Argyris (2002) defined the single-loop learning as a process that makes people simply change their action in a changing environment. On the opposite, the author defined double-loop learning as the process which makes people really question the different variables that affect changes and global performance. These single and double learning loops can recall the two main cycles of ABC performance measurement displayed in Figure 16 and Figure 17. Indeed, the white arrow can be considered as a single-loop learning since the Measure→Analyse→Act cycle aims at changing the improvement actions according to what is measured and analysed. Besides, the yellow arrow can be considered as a double-loop learning in a sense that this review loop aims at compelling people to question on their main assumptions and strategies.

**Intuition**

As presented in the literature review, one of the outcomes of performance measurement is to avoid using intuition in decision making (Lantelme and Formoso, 1999). According to the case study, the implementation of performance measurement has indeed largely led to avoid to only use intuition and experience in order to take decisions at ABC. However, there is the example of the construction site Productivity indicator, presented in part 4.3., which has been built by using the intuition of the construction site manager. Thus, it is possible to think that we made an error by choosing the approach of intuition in order to overcome the difficulty. This intuition deals with the planned performance, and according to the literature review, performance measurement can also be measured against planned performance in order to get a sense of effectiveness (Cox et al., 2003). Therefore, using intuition to build the construction sites Productivity indicator within ABC could be a successful approach. Nevertheless, it is essential to try to assess intuition to predict the planned performance. It can be done for example by trying to draw a complexity matrix that allows to group different types of construction sites, used materials, worker skills, weather, etc. However, this approach needs time to be implemented as well as a deep understanding of the many inherent variables.
6. Discussion

This chapter aims at discussing the main outcomes of the Analysis part by summarizing the similarities and gaps identified between the literature review and the case study and by giving additional comments.

According to the structure of the analysis part, the recommendations can be divided according three main parts: KPI identification, PMS design, and PMS practical implementation.

6.1. KPI identification

The choice of the indicators is really important in order to successfully implement performance measurement. Literature particularly recommends to implement leading and balanced measures. As stated in the analysis, ABC’s dashboards allow following KPIs that are leading and relatively balanced measures according to the criteria of the literature review. Indeed, the implemented measures are leading since they bring the opportunity to change by allowing to take corrective actions in order to improve performance. Moreover, it is helped by the Measure→Analyse→Act approach implemented. Then, the implemented measures are balanced because they allow to get a large picture of performance with four areas (Safety, Quality, Delay, and Productivity) all along the construction process. Nevertheless, there are no financial measures displayed in ABC’ dashboards. I would suppose that this big difference between literature recommendations and the case study comes from the fact that financial figures are often taboo in French companies’ culture. Then, regarding the discussion of the ABC’s performance areas in the literature, two particular quality indicators areas have been identified in ABC’s dashboards compared to the traditional construction set of KPIs. These are the supplier quality and the long term customer satisfaction. Modular construction firms rely indeed more on their suppliers. Moreover, the difference regarding the “long term” customer satisfaction can be explained by the quite important amount of buildings that ABC rents to its customers.

6.2. PMS design

The PMS design is then really important in order to build a solid framework which enables all the employees to use the measures. There is a similarity between the implemented performance measurement approach (Measure→Analyse→Act) at ABC and the Deming cycle. There is also a strong similarity between the ABC PMS and the Bourne et al. (2000) model. Indeed, the approach Measure→Analyse→Act is even included in Bourne et al. (2000) model.
Two main cycles can be identified in the ABC PMS:

- The **use cycle** supported by the Measure→Analyse→Act approach, and
- The **review cycle** aiming at challenging the main assumptions and strategy of the company. The literature review especially stated that a review cycle is necessary to conduct change.

As explained in the analysis, the use cycle can be seen as included in a bigger loop that constitutes the review cycle.

### 6.3. PMS practical implementation

Finally, the practical implementation of performance measurement is rather complex. The **key success factors** for implementation identified in the literature review have been mostly verified in the case study. However, three of them have not been clearly verified. There are now discussed in turn:

- **Link to the strategy**
  The link to the strategy was present in the ABC PMS. For example, this link can be observed thanks to the black arrows in Figure 18. However, I have not been able to identify this as a success factor for the implementation of performance measurement. Actually, I think that more time is needed in order to verify this key success factor. It needs indeed observation during the use time, whereas the case study was mainly focused towards the implementation time.

- **Benchmarking**
  Although Benchmarking, which allows to set levels in the measures, was cited as a key success factor in the literature review, it was not used in the case study. This can be due to the context of ABC that faced a high level of confidentiality, and therefore does not want to share and compare data with other companies. Moreover, it is possible to find a paradox in this issue since literature recommends both to use Benchmarking and to develop “home-made” performance measurement tools. Indeed, it seems sometimes difficult to compare measures that have been collected with different “home-made” tools. Nonetheless, internal Benchmarking can be used in order to make the company progress by comparing data between factories and departments of the company.

- **Simplification of the measures**
  Some authors (e.g. Lantelme and Formoso, 1999) really considered that it is really important to simplify the measures as much as possible in order to ensure that every employee understands. On the other hand, other authors (e.g. Berry, 1983) underlined the fact that simplification of the measures could skew the reality. Therefore, a trade-off is needed between reality representation and understanding of everyone.
All the barriers identified in the literature review have been verified in the case study. The performance measurement issues identified in the literature review have also been verified. Moreover, the case study brings examples to illustrate the double support linkage that exists between performance measurement and organisational learning. It has also been noted that the two cycles of the ABC PMS recall the concept of the double-loop learning from the organisational learning literature. However, two gaps have been found regarding these performance measurement issues:

- **The use of manual indicators**
  Manual indicators have been preferred at ABC although literature recommends automating as much as possible. Within ABC, choosing manual indicators was a way to encourage employees to use the measures by making it more interactive and easy to use. However, regarding totally manual indicators, there is a lack for data storage that can be useful for analysis phases. But the thesis was focused on the implantation phase and I think that manual indicators can be more efficient regarding this phase. They can always be automated afterwards in order to save time and to be able to store data.

- **The use of intuition**
  Intuition has been used to build a few measurement models at ABC whereas literature states that performance measurement should avoid the use of intuition in decisions making. However, intuition has been used when there was no other solution and it was planned to try to “assess” intuition. Therefore, it is not a recommended solution for the long term, but it can help to collect a first draft of data.

### 6.4. Performance measurement trade-offs

According to the research question presented at the beginning of the report (see 1.2.), the theoretical verification previously conducted has allowed to identify three kinds of trade-offs that must be considered in order to successfully implement performance measurement within a company:

- **Perceived benefits of PM and effort required**
  In order to successfully implement performance measurement, managers must make a trade-off between the perceived benefits and the effort required in order to motivate employees.

- **Accuracy of the data and cost of measurement**
  Accurate data are more expensive to obtain. The required accuracy of the data needs to be previously defined. Very accurate data are not always the most efficient way to measure performance and the cost of measurement is really important to take into account.
Reality representation and understanding for everyone
In one hand, simplification of the measures is good since it allows a better understanding among the employees. On the other hand, simplification can skew the reality and bring a wrong picture of the factors that affect performance in the company.

6.5. Methodology reflection

As stated in the Methodology part in 2.1., a parallel research design has been conducted for this thesis, including an empirical case study. Afterwards, it appears that the value added of this report mainly comes from this case study. Indeed, it allowed verifying some indicators for construction industry, as well as key success factors and barriers for implementation. Moreover, it also allowed to bring a structured performance measurement approach (Measure → Analyse → Act) that has been verified according to some literature recommendations.

Even though the study relies on only one case study, my total implication in the implementation task allowed to give it more value. Indeed, the fact that I was entrusted a real mission within the company allowed me to conduct real implementation actions that increased my understanding of the performance measurement issue. Furthermore, I have been in real situations of implementation and “first use” of indicators and for example, I have been directly confronted to some of the human behaviour issues previously discussed in this thesis.

Some of the results from the analysis are only valid regarding construction industry. Indeed, the results from the part dealing with KPI identification cannot be extended to manufacturing industry in general since this part was focused on KPI identification for construction industry. However, the results from the other parts dealing with PMS design and PMS implementation are not proper to construction industry so they can be easily extended to other manufacturing industries. For example, the implemented performance measurement approach (Measure → Analyse → Act) with the reviewing system, the structure of the indicators dashboards, and the overall pyramidal design with monitoring rooms and rituals constitutes an overview of practical implementation techniques that can be used in other manufacturing industries. Finally, the results collected through this thesis can be used to give an answer to the research question.
7. Conclusion

This chapter aims at concluding the thesis by giving an answer to the research question.

“- I think we improved compared to last year ... - Ok, show me the data!”

As stated in the thesis, performance measurement aims at evaluating an improvement, by especially “showing the data”. Moreover, the thesis showed that performance measurement could do really more than just assessing improvements. Indeed, it also allows to identify poor performance areas, to analyse the root causes of poor performance, and especially to look for improvement actions. Therefore, measuring, which has no real value itself, is just a first step of the performance measurement approach whose the final goal is to improve performance. Nevertheless, performance measurement implementation is rather complex and the aim of this thesis was to answer the following question:

How to successfully implement performance measurement within a company?

First of all, the choice of the indicators is important. They have to be leading indicators and offer the opportunity to change by enabling people to take corrective actions. The chosen set of indicators must also give a balanced view of performance within the organisation by displaying different kinds of quantitative and qualitative indicators.

Furthermore, a structured system is needed in order to support a performance measurement approach. This system must ensure the good standard of working regarding performance measurement in the whole organisation and must cover all the hierarchical levels. This system should be supported by visual dashboards and periodic meetings. With the support of this thesis and the work done at ABC, I propose that the measuring system should contain at least the three following phases: Measure, Analyse, and Act (as implemented at ABC). The system must also be cyclic and contains some review loops aiming at conducted changes, as well as challenging some strategic assumptions.

Choice of indicators and structured system both constitute the basis of a successful performance measurement implementation. However, there are also several practical issues to deal with. Therefore, regarding practical implementation of performance measurement, the thesis verified the five following key success factors.

- Perceived benefits of performance measurement
- Continued top management commitment
- Worth effort
- Structured framework
- Employee involvement
Moreover, the **five** following **barriers** for implementation have also been verified:

- Time and effort required
- Human behaviour
- Data access
- Finding appropriate measures
- Employee skills

Finally, the successfulness of performance measurement implementation is not straightforward and three **performance measurement trade-offs** have been identified in order to successfully implement performance measurement within a company:

- Perceived benefits of performance measurement and effort required
- Accuracy of the data and cost of measurement
- Reality representation and understanding for everyone.

The thesis also described the strong double linkage existing between performance measurement and organisational learning. Reinforced by this strong linkage, Performance Measurement is an important key driver of Continuous Improvement.
8. References

Books and scientific articles:


**Standards:**
