3. RESEARCH METHOD ........................................................................................................ 66

3.1. Introduction .................................................................................................................. 67

3.2. Introduction to the case study method ....................................................................... 67

3.2.1. Framework of study ............................................................................................... 68

3.3. Stage one: plan ........................................................................................................... 70

3.3.1. Exploratory case study approach ........................................................................... 71

3.3.2. Unit of analysis ....................................................................................................... 72

3.3.3. Qualitative and quantitative research .................................................................... 75

3.4. Stage two: design ....................................................................................................... 80

3.4.1. Identification and selection of case-study projects ............................................... 81

3.4.2. Case-study approach ............................................................................................. 84

3.5. Stage three: prepare .................................................................................................. 85

3.5.1. The pilot case-study project ................................................................................... 86

3.6. Stage four: collect ..................................................................................................... 88

3.6.1. Data source ............................................................................................................. 91

3.6.2. Dependent and independent variables .................................................................... 99

3.7. Stage five: analyze .................................................................................................... 102

3.7.1. Explanatory building ............................................................................................. 103

3.7.2. Cross-case analysis ............................................................................................... 104

3.7.3. Data coding ........................................................................................................... 105

3.7.4. Scheduling and time-related calculations ............................................................. 105

3.7.5. Cost-related calculations ....................................................................................... 110

3.7.6. Sustainability-related calculation .......................................................................... 115

3.8. Stage six: share ......................................................................................................... 118

3.8.1. Verification of methodology .................................................................................. 119

3.8.1.1. Published research article ................................................................................... 120

3.8.1.2. Interviews with subjects involved ....................................................................... 121

3.9. Chapter summary ...................................................................................................... 122

4. CASE-STUDY PROJECTS .............................................................................................. 123

4.1. The school project ...................................................................................................... 124

4.1.1. Brief project history ............................................................................................... 126

4.1.2. Why choosing this case-study project ................................................................... 131

4.2. The nursing-home project ......................................................................................... 132

4.2.1. Brief project history ............................................................................................... 134

4.2.2. Why choosing this case-study project ................................................................... 141

4.3. The office-building project in Barcelona ................................................................. 142
5. RESULTS ................................................................. 154

5.1. Introduction .......................................................... 155

5.2. Interviews ............................................................ 155

5.2.1. Categorization of interviewees .................................. 155

5.2.2. Qualitative interviews .......................................... 159

5.3. Dependent variables .................................................. 165

5.3.1. Lack of integration between technicians and green-building tasks ............ 166

5.3.2. Misunderstanding of Commissioning Authority's tasks and process .......... 168

5.3.3. No appropriate clause in bid documentation .......................... 169

5.3.4. Systematic cuts to budget due to change-orders and delays ..................... 173

5.3.5. Misunderstanding of the energy-model role and process ...................... 176

5.4. Lean project wastes .................................................... 178

5.5. Independent variables ................................................ 184

5.5.1. Time .................................................................. 184

5.5.2. Costs ................................................................ 185

5.5.3. Sustainability ....................................................... 188

5.6. Research outputs ....................................................... 189

5.6.1. Case-study 1: the nursing-home complex .............................. 190

5.6.2. Case-study 2: the school complex .................................. 195

5.6.3. Case-study 3: the office building in Barcelona ......................... 198

5.6.4. Case-study 4: the office building in Southern Spain .................. 201

5.6.5. Output summary .................................................. 203

5.7. Case-study comparison and cross-case analysis ............................. 204

5.8. Practical guidelines for professionals .................................. 213

5.9. Chapter summary ...................................................... 218

6. CONCLUSIONS .............................................................. 219

6.1 Achievement of the research objectives .................................. 220

6.2 Contributions ............................................................ 221

6.3 Limitations ............................................................... 224
6.4 Ideas for future researches ................................................................. 227
6.5 Chapter summary .............................................................................. 229

7. BIBLIOGRAPHY ................................................................................. 230
8. APPENDIX ......................................................................................... 238
LIST OF FIGURES

1.1 Representation of the contractual dependencies between subjects involved in the Design-Bid-Built European and U.S. construction process ...................................................... 4

1.2 Brief representation of the main research phases implemented for the purpose of the present study. .......................................................................................................................... 7

2.1 Graphical representation of the “iron triangle” (Atkinson – 1999) ........................................... 44

2.2 Representation of the contractual dependencies between subjects involved in the Design-Bid-Built European and U.S. construction process ................................................. 49

2.3 Snapshot of the graphic diagram reported by “The Telegraph” showing the number of days required to get construction permits within EU and USA (Quilty-Harper, 2011) ... 50

2.4 Snapshot of the graphic diagram reported by “The Telegraph” showing the number of days required to enforce a contract within the major EU countries and the USA (Quilty-Harper, 2011) .................................................................................................................................................. 51

2.5 Snapshot of the graphic diagram reported by “The Telegraph” showing the average number of days required to get construction permits, electricity connected, contracts enforced and goods exported within the major EU countries and the USA (Quilty-Harper, 2011) .................................................................................................................................................. 51

2.6 Representation of the Macleany curve showing the difference between traditional and integrated process from work management point of view. Within the representation readers can see: 1. Ability to impact costs and functional capabilities; 2. Cost of design changes; 3. Traditional design process; 4. Integrated project delivery process (Source: MSA Project Delivery) (Macleamy, 2004) ........................................................................................................ 64

3.1 Framework summarizing the methodology milestones for the present research project ........................................................................................................................................ 69

3.2 Snapshot of the final list summarizing all categories of issues identified with related activities and issues ........................................................................................................... 98

3.3 Figure 3.3 A: snapshot of the initial WBS scheme developed for the scope of the scheduling chapter ................................................................................................................. 107

Figure 3.3 B: milestones affected by green-building issues (delays) ........................................ 107
Figure 3.3 C: snapshot of the WBS-diagram breakdown to the detail of the problems that affected the process schedule ..............................................................108
Figure 3.3 D: identification of the WBS key-elements (in green color) that were used for the development of the AON network .................................................................108

3.4 Snapshot of the project Gantt diagram showing problems (red), problem-related activities (orange), sustainability-related activities (green) .......................................................109

3.5 Snapshot of part of the project checklist developed after the first kick-off meeting with the design team ..............................................................................................................................117

5.1 Snapshot of the project Gantt diagram showing problems (red), problem-related activities (orange), sustainability-related activities (green) and project-management-related activities (yellow) ........................................................................................................................185
# LIST OF TABLES

3.1 Example of qualitative and quantitative classification of problems identified during the process ........................................................................................................................................... 77

3.2 Example of the list of events developed for the first step of the qualitative interview.. 95

3.3 Example of the list of events and related issues developed for the second step of the qualitative interview .................................................................................................................................... 96

3.4 Portion of the checklist developed for the second round of qualitative-interview analysis ................................................................................................................................................... 100

5.1 Summary of the interviewees categorization for each case-study project ............... 156

5.2 Example of the list of milestones developed for the first step of the qualitative interview ........................................................................................................................................... 160

5.3 Example of the problem listing for one single milestone developed through the qualitative interview phase .................................................................................................................................... 161

5.4 Example of the list of events and related issues developed for the second step of the qualitative interview ..................................................................................................................................... 162

5.5 Table showing an example of the process implemented to related project-management issues with types of Lean waste ........................................................................................................................................... 164

5.6 Identification of project milestones affected by Lean waste ........................................ 164

5.7 Table summarizing the direct and indirect costs generated by all problem categories 188

5.8 Results proceeding from the analysis of project costs divided in direct and indirect costs values of the nursing-home project ...................................................................................................................................... 190

5.9 Results proceeding from the analysis of project-related delays for the design-development period ........................................................................................................................................... 191

5.10 Results proceeding from the analysis of project-related delays for the design-development period .......................................................................................................................................... 192

5.11 Snapshot of the LEED checklist implemented for the nursing-home project ........... 193

5.12 Final table summarizing all information obtained from the analysis of the present case-study project ........................................................................................................................................... 195

5.13 Results proceeding from the analysis of project costs divided in direct and indirect costs values of the school-complex project ........................................................................................................................................ 196

5.14 Results of the time-related analysis applied to the school-complex case study ....... 196
5.15 Results of the sustainability-related analysis applied to the school-complex case study
........................................................................................................................................... 198

5.16 Final table summarizing all information obtained from the analysis of the school-complex
case study ...................................................................................................................................... 198

5.17 Results proceeding from the analysis of project costs divided in direct and indirect costs
values of the office-building project in Barcelona ....................................................................... 199

5.18 Results of the time-related analysis applied to the office building case ......................... 199

5.19 Results of the sustainability-related analysis applied to the office building case located in
Barcelona ...................................................................................................................................... 200

5.20 Final table summarizing all information obtained from the analysis of the office-building
case in Barcelona ......................................................................................................................... 200

5.21 Results proceeding from the analysis of project costs divided in direct and indirect costs
values of the office-building project in Barcelona ....................................................................... 201

2.1 Results of the time-related analysis applied to the office building case of Southern Spain
.................................................................................................................................................. 202

5.22 Results of the sustainability-related analysis applied to the office building case of
Southern Spain ................................................................................................................................. 202

5.23 Final table summarizing all information obtained from the analysis of the office-building
case located in Southern Spain ..................................................................................................... 203

5.24 Final table summarizing all information obtained for all case studies ......................... 203

5.25 Table Impact of the types of Lean-waste on the direct and indirect cost variance of each
case study ...................................................................................................................................... 225

5.26 Impact of the types of Lean-waste on the direct and indirect cost variance of each case
study ............................................................................................................................................... 216

5.27 Impact of the types of Lean-waste on the time variance of each case study ............... 217

5.28 Impact of the types of Lean-waste on the time variance of each case study ............... 217

6.1 Summary of the research objectives achieved with the present study ...................... 220