6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Productivity is a complex issue in construction where it is extremely difficult to measure due to the heterogeneity of the industry's products as well as its inputs. This study reports the findings of two questionnaire surveys of large Sri Lankan construction companies and consultant firms, where no attempt was made to measure any type of productivity, but where respondents were asked to express their opinions as to what aspects are likely to contribute best to productivity increases in their activities. The rate of return was 29% and 30% for contractors and consultants, respectively. The general conclusions and major findings are presented below.

When asked about the priorities in productivity improvement areas, Contractors awarded high ratings to functions, namely office management, site management, estimating, cost control, scheduling, safety management, communications and function integration. All these functions are in the management category. Other priorities in productivity improvement areas given by contractors are materials delivery, procurement, labour turnover, labour availability, labour working hours, labour relations, labour training, quality control, contract agreement, design standards, practices, specifications, selecting sub-contractors.

On the other hand responding consultants were satisfied with all functions except office management, site management, estimating, design standards, design practices, drafting and specifications.

Most of the contractors indicated that they would participate in productivity improvement groups and projects, and a few percentage were willing to contribute funds for the programmes. Consultants appeared to be less interested than contractors in pursuing activities designed to enhance construction productivity.

Consultants believed that they were not qualified to respond to materials and equipment management related questions.

6.2 Recommendations

It is recommended that future research be concentrated in productivity improvement areas where the high ratings were given by contractors and consultants.

Both contractors and consultants are willing to cooperate in any productivity enhancement programme but neither are willing to fund such activities. Special funding by the government appears to be necessary to support such costly programmes.

It very likely that lack of interest on the part of designers in the design phase may cause productivity problems for contractors during the construction phase. Designers awareness materials and equipment issues could improve construction productivity.

The subjective assessment approach used in this study eliminates the inherent difficulties normally encountered when measuring productivity in specific functions. It may indeed constitute a model that can be used in different countries of different times to survey professional's perceptions, to compare with similar results in other countries, and to track trends over the years. It is recommended that surveys be conducted every 3 -4 years to observe and identify new trends in the industry and to steer research in the appropriate direction. Effective co-ordination of such research and fast communication of results to all parties in the construction industry, especially designers, construction managers and contractors, are necessary.

References

1. Arditi. D. and Mochtar. K. (1996). Productivity Improvement in the Indonesian construction industry. *Construction Management and Economies*, 14. 13-24.

2. Assaf S.A., Al-Khalil M. and Al-Hazmi M. (1995) causes of delay in large Building Construction Projects *Journal of Management in Engineering* Vol 11, No.02, 45-50.

3. Baldwin J.R. and Manthei J.M. (1971) "Causes of delay in the Construction Industry"J.Constr. Div. ASCE, 97(2), 177-187.

4. Chalabi F.A. and Camp D. (1984) "Causes of delays and overruns of Construction Projects in Developing Countries" (IB Proc. W 65, Vol.2, 723-734.

5. Fereig S. and Qaddumi N. (1984) "Construction problems - Arabian Gulf experience" CIB Proc. W-65, Vol.2, 753-756.

6. Ganeshan S. (1985) Construction Productivity. Habitat International 5, ¾

7. Horner M.W. and Talhouni B.T.K. January 1996, CACS Construction Bulletin. No. 11.

8. Jayawardana, A.K.W. (1992) Wastage building construction sites – what the Sri Lankan contractor's say? *Proc. Of the annual sessions of the Institution of Engineers, Sri Lanka*,114-127.

9. Jayawardana, A.K.W. (1994) Are we aware of the extent of wastage on our building construction sites? *Engineer, Journal of the Institution of Engineers, Sri Lanka* XXII(I), 41-54.

10. Jayawardana, A.K.W. (1995) Wastage on building construction sites in Sri Lanka. *Asia Pacific Building and Construction Management Journal, Hongkong*, I(I)

11. Jayawardana, A.K.W. and Srikumaran, K (1996a) Organization of site management for building projects – A review, *Engineer, Journal of Institution of Engineers, Sri Lanka*.

12. Jayawardana, A.K.W. and Srikumaran, K (1996b) Some Aspects of Project Control by Major Contractors– A review, *Engineer, Journal of Institution of Engineers, Sri Lanka.*

13. "Measuring Productivity in Construction" (1982) A-1 . Report of the Construction Industry Cost Effectiveness Project. The Business Roundtable, Newyork, N.Y.

14. Thomas H. R, Maloney W.F. and Horner R. M. W. (1990) Modeling Construction Labour *Productivity Journal of construction Engineering and Management.* Vol 116, No.04. Pages 705-726.

15. Thomas H.R. and Kramer D.F. (1987) " The Manual of Construction Productivity Measurement and Performance Evaluation." *Source Document 35, Construction Industry Institute,* Austing, Tex.

16. Thomas H.R. and Mathews c.T. (1985), "An Analysis of the Methods of Measuring Construction Productivity." *Construction Industry Institute*, Austin, Tex.

DIAGNOSING PRODUCTIVITY PROBLEMS AND IDENTIFYING PRIORITIES

- CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE -
For Contractors

We are at present carrying out research on the above topic with the main objectives being to analyse the Sri Lankan Construction Industry at sectoral level, diagnose productivity problems, identify priorities and the type of action the Practitioners are willing to take, to improve construction productivity.

We have identified that "Structured Questionnaire Survey among Contractors, Consultants and Clients" is the best method to collect the necessary information.

Since we have limited time for this study, I shall be very grateful if you could complete this questionnaire and return it in the stamped envelope provided by 15th June 1998.

Any individual information collected will be kept confidential and will be used only for study purposes.

Thank you for your co-operation.

Dr. A. K. W. Jayawardane,
Senior Lecturer,
Construction Engineering and Management Division,
Department of Civil Engineering,
University of Moratuwa,
Moratuwa.

N.B. We have noted that you have not returned the previous questionnaire which we sent as a pilot study. We shall be very grateful if you could devote a little time to provide necessary information to make this project a success, even at this stage.

Thank you.

Instructions to fill the Questionnaire :

This questionnaire has to be completed by a Senior Manager / Chief Engineer in charge of overall management of projects. The questionnaire will take only about 10-15 minutes to complete. Please tick box for each question, the response that most closely corresponds to your view. You may tick more than one response per question wherever relevant.

CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

Name of Company : .....

Address : .....

Company Grade (ICTAD) : .....

Name of Person/Designation (optional) : .....

Contact Tel. No: (optional) .....

1. Type of Contractor

   Building (Educational, Commercial, etc.) ☐

   Engineering (Highway, Heavy) ☐

   Industrial (Power Plants, Refineries etc.) ☐

2. Annual Construction Turnover (Millions of Rupees)

   Under 25 ☐ 10 - 50 ☐ 50 - 100 ☐ 100 - 500 ☐ > 500 ☐

3. Number of Permanent Employees

   Under 100 ☐ 100 - 500 ☐ 500 - 1000 ☐ 1000 - 5000 ☐

4. Number of Temporary Employees

   Under 100 ☐ 100 - 500 ☐ 500 - 1000 ☐ 1000 - 5000 ☐

5. Value of construction equipment owned by the Company (Millions of Rupees)

   Under 5 ☐ 5 - 25 ☐ 25 - 50 ☐ 50 - 200 ☐ > 200 ☐

6. Percentage of construction equipment leased or rented

   None ☐ Under 25% ☐ 25 -50% ☐ 50 - 75% ☐ 75 - 100% ☐

7. Amount of work (by Rupee value) sub-contracted on average job

Under 25% ☐ 25 - 50% ☐ 50 - 75% ☐ 75 - 100% ☐

8. Geographic location of projects

Please tick the district having the most number of projects.

Colombo	☐	Kegalle	☐
Gampaha	☐	Hambantota	☐
Kalutara	☐	Kurunegala	☐
Kandy	☐	Puttalam	☐
Matale	☐	Anuradhapura	☐
Nuwara Eliya	☐	Polonnaruwa	☐
Galle	☐	Badulla	☐
Matara	☐	Moneragala	☐
Ratnapura	☐		

9. Rate the following functions for potential with respect to opportunity for productivity improvement.

	Very Important	Important	Somewhat Important	Not Important
Materials				
Procurement	☐	☐	☐	☐
Delivery	☐	☐	☐	☐
Storage	☐	☐	☐	☐
Packaging	☐	☐	☐	☐
Prefabrication	☐	☐	☐	☐
Standardization	☐	☐	☐	☐
Product availability	☐	☐	☐	☐
New products	☐	☐	☐	☐
Labour				
Turnover	☐	☐	☐	☐
Availability	☐	☐	☐	☐
Working hours	☐	☐	☐	☐
Labour relations	☐	☐	☐	☐

	Very Important	Important	Somewhat Important	Not Important
Contract agreement	☐	☐	☐	☐
Training	☐	☐	☐	☐
Quality control	☐	☐	☐	☐
Management				
Office management	☐	☐	☐	☐
Site management	☐	☐	☐	☐
Estimating	☐	☐	☐	☐
Cost control	☐	☐	☐	☐
Scheduling	☐	☐	☐	☐
Resource allocation	☐	☐	☐	☐
Integration of Design/ Estimating/Scheduling/ Control functions	☐	☐	☐	☐
Field inspection	☐	☐	☐	☐
Safety management	☐	☐	☐	☐
Marketing	☐	☐	☐	☐
Communications :				
- within company	☐	☐	☐	☐
- with designer	☐	☐	☐	☐
- with sub-contractors	☐	☐	☐	☐
- with research organisations	☐	☐	☐	☐
Engineering				
Design standards	☐	☐	☐	☐
Design practices	☐	☐	☐	☐
Drafting	☐	☐	☐	☐
Specifications	☐	☐	☐	☐
Construction Techniques				
Pre-cast Elements	☐	☐	☐	☐
Pre-assembled Modulars	☐	☐	☐	☐
Foreign Developments	☐	☐	☐	☐

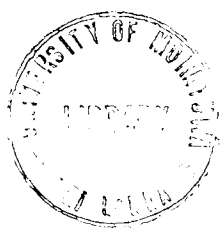
	Very Important	Important	Somewhat Important	Not Important
Contracting				
Risk distribution among parties	☐	☐	☐	☐
Bonding	☐	☐	☐	☐
Insurance	☐	☐	☐	☐
Selecting general contractor	☐	☐	☐	☐
Selecting designer	☐	☐	☐	☐
Selecting sub-contractors	☐	☐	☐	☐
Design build contracting	☐	☐	☐	☐
Construction management contracting	☐	☐	☐	☐
Incentive/Disincentive clauses	☐	☐	☐	☐
Dispute resolution methods	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

Computer Utilization in Office Management				
Drafting	☐	☐	☐	☐
Specifications	☐	☐	☐	☐
Marketing	☐	☐	☐	☐
Structural design	☐	☐	☐	☐
Architectural design	☐	☐	☐	☐
Cost estimating	☐	☐	☐	☐
Scheduling planning	☐	☐	☐	☐
Cost accounting	☐	☐	☐	☐
Personnel management	☐	☐	☐	☐
Safety monitoring	☐	☐	☐	☐
Material management	☐	☐	☐	☐
Equipment management	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

	Very Important	Important	Somewhat Important	Not Important
Labour Productivity Improvement Techniques				
Work Sampling	☐	☐	☐	☐
Goal setting	☐	☐	☐	☐
Quality circles	☐	☐	☐	☐
Motion analysis	☐	☐	☐	☐
Time study	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

10. Indicate the types of action your organisation would take in the interest of improving productivity.

- Serve as a member of a group that identifies productivity problems ☐
- Contribute funds (together with other Companies) to support programmes ☐
- Help develop a project aimed at improving construction productivity ☐
- Conduct (or participate) in a project aimed at improving construction productivity ☐
- Evaluate the results of a project aimed at improving construction productivity ☐
- Attend construction productivity conferences and meetings ☐
- Engage junior professionals in your organisation to attend conferences, meetings and short courses in construction productivity ☐
- Subscribe to a construction productivity information service ☐
- Others (specify) ☐



11. In addition to the above, if you could come out with any other problems, comments or solution directions to enhance construction productivity, please write them on a separate sheet and return with your completed questionnaire.

Thank you for your co-operation.

Appendix A-2

DIAGNOSING PRODUCTIVITY PROBLEMS AND IDENTIFYING PRIORITIES

- CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE - For Consultants

We are at present carrying out research on the above topic with the main objectives being to analyse the Sri Lankan Construction Industry at sectoral level, diagnose productivity problems, identify priorities and the type of action the Practitioners are willing to take, to improve construction productivity.

We have identified that "Structured Questionnaire Survey among Contractors, Consultants and Clients" is the best method to collect the necessary information.

Since we have limited time for this study, I shall be very grateful if you could complete this questionnaire and return it in the stamped envelope provided by 15th June 1998.

Any individual information collected will be kept confidential and will be used only for study purposes.

Thank you for your co-operation.

Dr. A. K. W. Jayawardane,
Senior Lecturer,
Construction Engineering and Management Division,
Department of Civil Engineering,
University of Moratuwa,
Moratuwa.

N.B. We have noted that you have not returned the previous questionnaire which we sent as a pilot study. We shall be very grateful if you could devote a little time to provide necessary information to make this project a success, even at this stage.

Thank you.

DIAGNOSING PRODUCTIVITY PROBLEMS AND IDENTIFYING PRIORITIES

- CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE -
For Consultants

We are at present carrying out research on the above topic with the main objectives being to analyse the Sri Lankan Construction Industry at sectoral level, diagnose productivity problems, identify priorities and the type of action the Practitioners are willing to take, to improve construction productivity.

We have identified that "Structured Questionnaire Survey among Contractors, Consultants and Clients" is the best method to collect the necessary information.

Since we have limited time for this study, I shall be very grateful if you could complete this questionnaire and return it in the stamped envelope provided by 15th June 1998.

Any individual information collected will be kept confidential and will be used only for study purposes.

Thank you for your co-operation.

Dr. A. K. W. Jayawardane,
Senior Lecturer,
Construction Engineering and Management Division,
Department of Civil Engineering,
University of Moratuwa,
Moratuwa.

Instructions to fill the Questionnaire :

This questionnaire has to be completed by a Managing Director/Chief Consulting Engineer in charge of overall management of projects. The questionnaire will take only about 10-15 minutes to complete. Please tick box for each question, the response that most closely corresponds to your view. You may tick more than one response per question wherever relevant. Some questions may not be directly relevant to your organisation or to your business but please attempt to answer them based on your own experience, wherever possible.

CONSTRUCTION PRODUCTIVITY QUESTIONNAIRE

Name of Company : .....

Address : .....

Name of Person/Designation (optional) : .....

Contact Tel. No: (optional) .....

1. Type of Consultant

   Building (Educational, Commercial, etc.) ☐

   Engineering (Highway, Heavy) ☐

   Industrial (Power Plants, Refineries etc.) ☐

2. Annual Turnover (Millions of Rupees)

   Under 5 ☐ 5 - 10 ☐ 10 - 50 ☐ 50 - 100 ☐ > 100 ☐

3. Number of Permanent Employees

   Under 10 ☐ 10 - 50 ☐ 50 - 100 ☐ 100 - 500 ☐ > 500 ☐

4. Number of Temporary Employees

   Under 10 ☐ 10 - 50 ☐ 50 - 100 ☐ 100 - 500 ☐ > 500 ☐

5. Amount of work (by Rupee value) sub-contracted on average job

   Under 25% ☐ 25 - 50% ☐ 50 - 75% ☐ 75 - 100% ☐

6. Geographic location of projects

Please tick the district having the most number of projects.

Colombo	☐	Kegalle	☐
Gampaha	☐	Hambantota	☐
Kalutara	☐	Kurunegala	☐
Kandy	☐	Puttalam	☐
Matale	☐	Anuradhapura	☐
Nuwara Eliya	☐	Polonnaruwa	☐
Galle	☐	Badulla	☐
Matara	☐	Moneragala	☐
Ratnapura	☐		

7. Rate the following functions for potential with respect to opportunity for productivity improvement.

	Very Important	Important	Somewhat Important	Not Important
Materials				
Procurement	☐	☐	☐	☐
Delivery	☐	☐	☐	☐
Storage	☐	☐	☐	☐
Packaging	☐	☐	☐	☐
Prefabrication	☐	☐	☐	☐
Standardization	☐	☐	☐	☐
Product availability	☐	☐	☐	☐
New products	☐	☐	☐	☐
Labour				
Turnover	☐	☐	☐	☐
Availability	☐	☐	☐	☐
Working hours	☐	☐	☐	☐
Labour relations	☐	☐	☐	☐

	Very Important	Important	Somewhat Important	Not Important
Contract agreement	☐	☐	☐	☐
Training	☐	☐	☐	☐
Quality control	☐	☐	☐	☐
Management				
Office management	☐	☐	☐	☐
Site management	☐	☐	☐	☐
Estimating	☐	☐	☐	☐
Cost control	☐	☐	☐	☐
Scheduling	☐	☐	☐	☐
Resource allocation	☐	☐	☐	☐
Integration of Design/ Estimating/Scheduling/ Control functions	☐	☐	☐	☐
Field inspection	☐	☐	☐	☐
Safety management	☐	☐	☐	☐
Marketing	☐	☐	☐	☐
Communications :				
- within company	☐	☐	☐	☐
- with designer	☐	☐	☐	☐
- with sub-contractors	☐	☐	☐	☐
- with research organisations	☐	☐	☐	☐
Engineering				
Design standards	☐	☐	☐	☐
Design practices	☐	☐	☐	☐
Drafting	☐	☐	☐	☐
Specifications	☐	☐	☐	☐
Construction Techniques				
Pre-cast Elements	☐	☐	☐	☐
Pre-assembled Modulars	☐	☐	☐	☐
Foreign Developments	☐	☐	☐	☐

	Very Important	Important	Somewhat Important	Not Important
Contracting				
Risk distribution among parties	☐	☐	☐	☐
Bonding	☐	☐	☐	☐
Insurance	☐	☐	☐	☐
Selecting general contractor	☐	☐	☐	☐
Selecting designer	☐	☐	☐	☐
Selecting sub-contractors	☐	☐	☐	☐
Design build contracting	☐	☐	☐	☐
Construction management contracting	☐	☐	☐	☐
Incentive/Disincentive clauses	☐	☐	☐	☐
Dispute resolution methods	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

Computer Utilization in Office Management				
Drafting	☐	☐	☐	☐
Specifications	☐	☐	☐	☐
Marketing	☐	☐	☐	☐
Structural design	☐	☐	☐	☐
Architectural design	☐	☐	☐	☐
Cost estimating	☐	☐	☐	☐
Scheduling planning	☐	☐	☐	☐
Cost accounting	☐	☐	☐	☐
Personnel management	☐	☐	☐	☐
Safety monitoring	☐	☐	☐	☐
Material management	☐	☐	☐	☐
Equipment management	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

	Very Important	Important	Somewhat Important	Not Important
Labour Productivity Improvement Techniques				
Work Sampling	☐	☐	☐	☐
Goal setting	☐	☐	☐	☐
Quality circles	☐	☐	☐	☐
Motion analysis	☐	☐	☐	☐
Time study	☐	☐	☐	☐
Others (specify)	☐	☐	☐	☐

8. Indicate the types of action your organisation would take in the interest of improving productivity.

- Serve as a member of a group that identifies productivity problems ☐
- Contribute funds (together with other Companies) to support programmes ☐
- Help develop a project aimed at improving construction productivity ☐
- Conduct (or participate) in a project aimed at improving construction productivity ☐
- Evaluate the results of a project aimed at improving construction productivity ☐
- Attend construction productivity conferences and meetings ☐
- Engage junior professionals in your organisation to attend conferences, meetings and short courses in construction productivity ☐
- Subscribe to a construction productivity information service ☐
- Others (specify) ☐

9. In addition to the above, if you could come out with any other problems, comments or solution directions to enhance construction productivity, please write them on a separate sheet and return with your completed questionnaire.

Thank you for your co-operation.

Appendix B - 1

RESPONDED CONTRACTORS

GRADE	CONTRACTOR
M1	International Construction Consortium Limited
M1	Link Engineering (Pvt) Ltd.
M1	Maga Engineering (Pvt) Ltd
M1	State Engineering Corporation
M1	Samuel & Sons Co. Ltd.
M1	Tudawe Brothers Ltd.
M1	Buildmart Lanka (Pvt) Ltd.
M2	Elemech Engineers (Pte) Ltd.
M2	CML Edward Construction
M2	Komuthi Engineering Services (Pvt) Ltd
M2	K.A.D. Weerasinghe & Company (Pvt) Ltd.
M3	J.B. Attanayake & Company (Pvt) Ltd
M3	Dharmasena & Co.
M3	Sri Lanka Land reclamation & Development Corporation

GRADE	CONTRACTOR
M3	Tissa Builders & Contractors
M3	U.M. Perera & Company
M3	Consulting Engineers & Contractors
M3	Jayaratne Contractors (Pvt) Ltd
M3	Square Mech Engineering (Pvt) Ltd
M4	A. Panditha & Sons (Pvt) Ltd
M4	Sarath Construction Co.
M4	Sripalie Construction (Pvt) Ltd
M4	Kapila Arc Engineering (Pvt) Ltd
M4	Nihal Construction
M5	Development Engineering Services Ltd
M5	G.V.M. Silva & Sons
M5	Common Amenities Board
M6	Contrad Engineers & Builders
M6	K.K.R. Builders

Appendix B - II

RESPONDED CONSULTANTS

1. Engineering Consultants Ltd.
2. Stems Consultants (Pvt) Ltd
3. Surath Wickramasinghe Associates
4. Built Environment Consultants (Pvt) Ltd
5. Resource Development Consultants Ltd.
6. Al Amano Steel Buildings Contracting (Pvt) Ltd.
7. Ranjan Nadesapillai Associates

8. Central Engineering Consultancy Bureau
9. State Engineering Consultants
10. Devonco (Lanka) Ltd.
11. Selvaratnam & Perera Associates
12. M & T Engineering Associates
13. Chandrasena & Partners
14. Design Team Three (Pvt) Ltd.
15. Ceywater Consultants (Pvt) Ltd.