

Rural Road Constructions Productivity Growth in Jordan

Nabil Hazim¹

*Department of Civil Engineering
Al-Ahliyya Amman University
Amman, Jordan*

ORcid # 0000-0001-6176-335X

Zaydoun AbuSalem²

*Department of Civil Engineering
Applied Science Private University
Amman, Jordan*

ORcid # 0000-0001-5151-5256

Nawal Louzi³

*Department of Civil Engineering
Al-Ahliyya Amman University
Amman, Jordan*

ORcid # 0000-0002-6880-5468

Abstract

The road construction projects in Jordan suffer from a lot of delay and cost overrun. This results from poor planning and unrealistic estimation productivity of the implementation units (workers and machines) which in return, affect negatively the overall economy of the country. The estimate of productivity in Jordan lack a clear and specific scientific reference, which is usually based on experiences in previous similar projects and does not take into account the different execution conditions between various projects.

This work is an attempt to find a scientific technique to estimate and improve the planning management in order to reduce the delay and cost overrun of the road construction projects in Jordan. In order to develop these projects, an actual study of productivity improvement of workers and machines are implemented and evaluated. Such improvement in the productivity can be achieved by revising and evaluating the standard productivity formats used by the Ministry of Public Works to make the needed improvements. A questionnaire is developed and distributed to some experts working in the road construction fields. A statistical analysis was done to have some recommendations and results in order to achieve the aim of this work.

Keywords- productivity, efficiency, effectiveness, total quality management, quality control.

I. INTRODUCTION

In road construction, productivity can be defined by Author [3], as labor productivity, that is, units of work placed or produced per man-hour. The inverse of labor productivity, man-hours per unit (unit rate), is also commonly used.

To improve productivity, we must be able to measure it, and we must be able to measure the effect of changes adopted on methods, effort, and systems. The measured values of productivity can then be compared either to those used to compile the estimate or to some production standards. Although no formal industry standards exist in North America, many sources of published productivity data, as well as the databases of various companies, can serve as production standards. The effectiveness and the relative efficiency of the labor used in the construction process to do what is required at

a given time and place are considered as the most important measures of labor productivity.

Authors in [1] indicated that in order to improve labor effectiveness, various factors can be addressed, including motivation, job safety, environmental factors, and physical limitations. Management practices include scheduling, planning, data collection, job analysis, and control. Material timeliness is ensured by proper procurement scheduling, site layout, and other issues.

While, productivity can be influenced and affected by many factors such as; project conditions, market conditions, design and procurement, construction management, labor, government policy, education and training factors, weather variability, material shortages, lack of experienced design and project, management personnel, large number of changes, ineffective communications, inadequate planning and scheduling, lack of sufficient supervisory training, restrictive union rules, slow approvals and issue of permits, lack of management training for supervision, overtime, morale and attitude, fatigue, stacking of trades, joint occupancy, beneficial occupancy, concurrent operations, absenteeism and turnover, mobilize/demobilize, errors and omissions, start/stop, reassignment of manpower, late crew build-up, crew size, inefficiency, site access, logistics, security check, learning curve, ripple effect, confined space, hazardous work area, dilution of supervision, holidays, shorter daylight hours, weather and season changes, rain, shift work, working in operating area, over-manning, tool and equipment shortage, area practices, proximity of work, alternating, staggered, or rotating work schedules As observed by Author [2].

In order to achieve the targeted productivity goals, the work schedule, cost, quality, and management relationships must be targeted and scheduled. Internal constraints such as finance, workforce, technology process, project characteristics and project characteristics management and external constraints such as economics, political, regulations and unforeseen circumstances must be applied to have a well productive road project construction.

II. IMPORTANCE OF THE RESEARCH FINDINGS

The findings of this study will provide proper guidelines for improving productivity in the road maintenance and rehabilitation sector by providing a list of critical productivity constrains for project managers, contractors, and generally all

Corresponding author: Zaydoun Abu Salem

parties who are involved in the improvement measure in taking action to reduce the cost of projects and increase the efficiency and productivity in maintenance and rehabilitation operations.

The research study assesses the important factors affecting labor productivity in road construction. Understanding these factors is helpful for the construction professionals who work on the initial phases of construction planning in order to efficiently deliver the project plan. The main goal of the research study is to provide essential information about factors affecting labor productivity to the project management teams who enable the project's success.

This research study is helpful for further research studies on construction management on road construction in other areas of Ethiopia. The findings of the study would inform the stakeholders about factors affecting labor productivity in road construction. This enlightens the way to solve problems related to poor labor performance and low productivity of labor. For the Construction Companies this gives guidance and an overview on Labor Productivity in road construction projects in building a suitable Labor Productivity Plan with its characteristic and condition.

III. SCOPE AND LIMITATIONS OF THE RESEARCH

Most road projects in Jordan are characterized by low productivity which results in overrun in cost and time. Problem of low productivity is critical and needs to be studied to alleviate this problem in the future and to make recommendations to overcome the critical causes in future infrastructure projects.

For this reason, analyses and the examination of the reports taken from the Jordanian Ministry of Rural and Public Works and the contractors companies involved in working in the road maintenance and rehabilitation for several infrastructure projects in Jordan over the years 2000-2008 were analyzed. These companies comprised a range of contractors, consultants, and subcontractors. The causes for low productivity in these projects were the actual causes that occur. Rank of the factors were identified based on their significance and identify the critical factors influencing productivity and consequently cost and time overrun.

Authors in [7] used SmartPlant Construction software that allows users to create a set of labor factors and values for factoring labor productivity of work packages. Users can load their own factors or use industry tables from trade groups or associations. They can also drag and drop components from the 3D model into a work package and let SmartPlant Construction automatically calculate man-hours based on preconfigured rules of progress, along with drawings and materials. Users can then add labor factors by selecting from a table of values that they can set and apply a labor factor to the entire work package.

Authors in [7] suggested that inefficient management of construction resources can result in low productivity. Therefore, it is important for contractors and construction managers to be familiar with the methods leading to evaluate the productivity of the equipment's and the laborers in different crafts. To achieve the income expected from any construction

project in general, it is important to have a good controlling hand on the productivity factors that contribute in the integrated production composition, like labor, equipment, cash flow, etc. Authors in [4] indicated the factors that are important for making proper decision in road construction projects are: road inventory, pavement, traffic, road structure, finance, activity, and resources.

Authors in [11] identify how infrastructure building has influenced economic growth along the way. The results suggest that infrastructure development can improve the economy and per capita production growth while increasing the income distribution of citizens along the Belt and Road. Building infrastructure can enhance the income distribution of residents in developed and developing countries, but has no huge impact on residents in evolving third world countries. Collaboratively, these results describe inflows and urban growth as important pathways in which construction of infrastructure can affect economic growth. Authors in [12] propose a variety of tactics to achieve higher job creation, a proper balance of capital and sustainable growth.

Authors in [13] suggested that enthusiasm is one of the factors influencing efficiency and that the effect of motivation and demotivation on success is necessary to assess. The main goal of their research is to define the key elements in Qatar Construction Industry-QCI that trigger motivation and demotivation. To determine these variables, research study, professional assessments and semi-structured interviews are conducted. Using these aspects to perform unique motivational schemes will contribute to improving QCI productivity. This research will provide insight into how to work with QCI's competitiveness problems ahead of a major global activity that Qatar will host in 2022.

Authors in [14] indicated a suitable approach was introduced to address issues surrounding the introduction of Total Productive Maintenance, which was very difficult for many manufacturing companies to make unsuccessful attempts at its adoption and include the aspects of cost-cutting and improved productivity.

IV. ROAD CONSTRUCTION LABOR PRODUCTIVITY MEASUREMENT

Different measures of productivity serve different purposes. It is important to choose a measure that is appropriate to the purpose. Authors in [10] explore the current situation of the construction of new country areas and the causes that obstruct the more growth of the Shaanxi Area.

Authors in [6] defined different aspects of measures as follows; economic models, project-specific models, activity-oriented models, the baseline productivity, measured mile, cumulative productivity, the project management index (pmi), conversion factors, productivity measurement techniques, difficulties in measuring productivity while authors in [9] evaluate the present state of development of new rural areas and the reasons that impede the further growth of the Shaanxi Province. Then look for the improvement route to even further enhance rural development.

V. FACTORS AFFECTING ROAD CONSTRUCTION LABOR PRODUCTIVITY

Authors in [5] indicated that the main problems of the construction industry are its declining rate of productivity and lack of productivity standards. There are numerous factors which have influence on labor productivity. These factors could be classified as: Industry related factors. (Industry related factors are such as design factor (repetition and complexity), building codes, construction technology, laws and regulations, job factors (job duration, size of the job and type of job), adverse, uncertain weather and seasonality and site location), Management related factors. (Management related factors are such as planning and scheduling, leadership, motivations and communication.

Authors in [5] gave basic knowledge about major factors of management strategy and stated “What is needed is a basic knowledge of how major factors of a management strategy, divorced from means, methods, materials, and job conditions, independently affect labor. These factors include the level of on-site management and coordination; workmen’s job security; labor experience; workmen’s long-term pacing; delays; and breaks in the work. Other management decisions significantly affect labor productivity especially decisions related to the flow of men and materials on the jobsite. However, these actions are particular to the job conditions encountered.” And Labor related factors are such as labor skill, motives and labor availability.

VI. METHODOLOGY FOR THIS RESEARCH

There were many factors affecting labor productivity in road construction projects but the most 20 main factors affecting labor productivity in road construction projects that has been selected for this study are shown in Figure 1 and Figure 2.

The relative importance index method (RII) is used to determine the most significant cause of poor labor productivity in road construction projects in Jordan depending on responses from respondents. The determination of significant and non-significant factors affecting labor productivity is performed using statistical tests. Statistical test using SPSS software, the correlation and the relativity of the data are checked. The significance of factors affecting labor productivity is determined by using hypothesis test and two tailed test.

A structured questionnaire survey approach is considered to study the impact of various attributes and factors affecting labor productivity in road construction projects in the study area. The Relative Importance Index method; (RII) was used here to determine labor perceptions of the relative importance of factors affecting labor productivity in road construction projects. The recommendation is based on the findings from the computation of the Relative Importance Index method (RII), ranking and the statistical analysis.

VII. QUESTIONNAIRE DISTRIBUTION

The target groups that had been considered in this study are workers in road construction projects in Jordan. Seven (7) road projects are selected which are known well organized and have a significant number of manpower. The road projects were similar to each other in terms of the road type under construction, human resource they had, the budget of the project and the like. Since the size is less than 30, there was no need to determine the sample size. The sample size of the research study comprised of 7 road projects type only. A total of 70 questionnaires was distributed to 7 road construction projects and 10 questionnaires distributed for each selected road construction projects Jordan. Face to face interview was considered to collect the data.

VIII. DATA MEASUREMENT

In this research, ordinal scales were employed. Ordinal scale is a ranking or a rating data that normally use integers in ascending or descending order as shown in Table 1.

Table I. Ordinal scale used for data measurement

Item	Very high Important	High Important	Medium Important	Low Important	Very low Important
Scale	5	4	3	2	1

The questionnaires are designed to collect data regarding the major factors affecting labor productivity in road construction projects in Jordan and analyzed hereunder. A total of 63 questionnaires were collected and valid out of 70 respondents solicited. Seventy (70) questionnaires were distributed to the selected 7 road construction projects in the study area. For each project, 10 questionnaires were distributed. Topography and site access, overtime, morale and attitude are the most affecting factors on the labor productivity. While, dilution of supervision, holidays, and alternating or rotating work schedules have no or little contribution on the labor productivity.

Also, it is clearly shown that motivation, which was represented by overtime factor, is extremely important. Non motivated employees can have several negative effects on the work. These include friction on the job, substandard output in quality, a high turnover of employees, absenteeism, tardiness, and many of the disciplinary problems that should be avoided. This result agrees with the findings in this research which concludes that the lack of motivation has always led to high staff turnover in the construction industry and to lack of continuity in the organization.

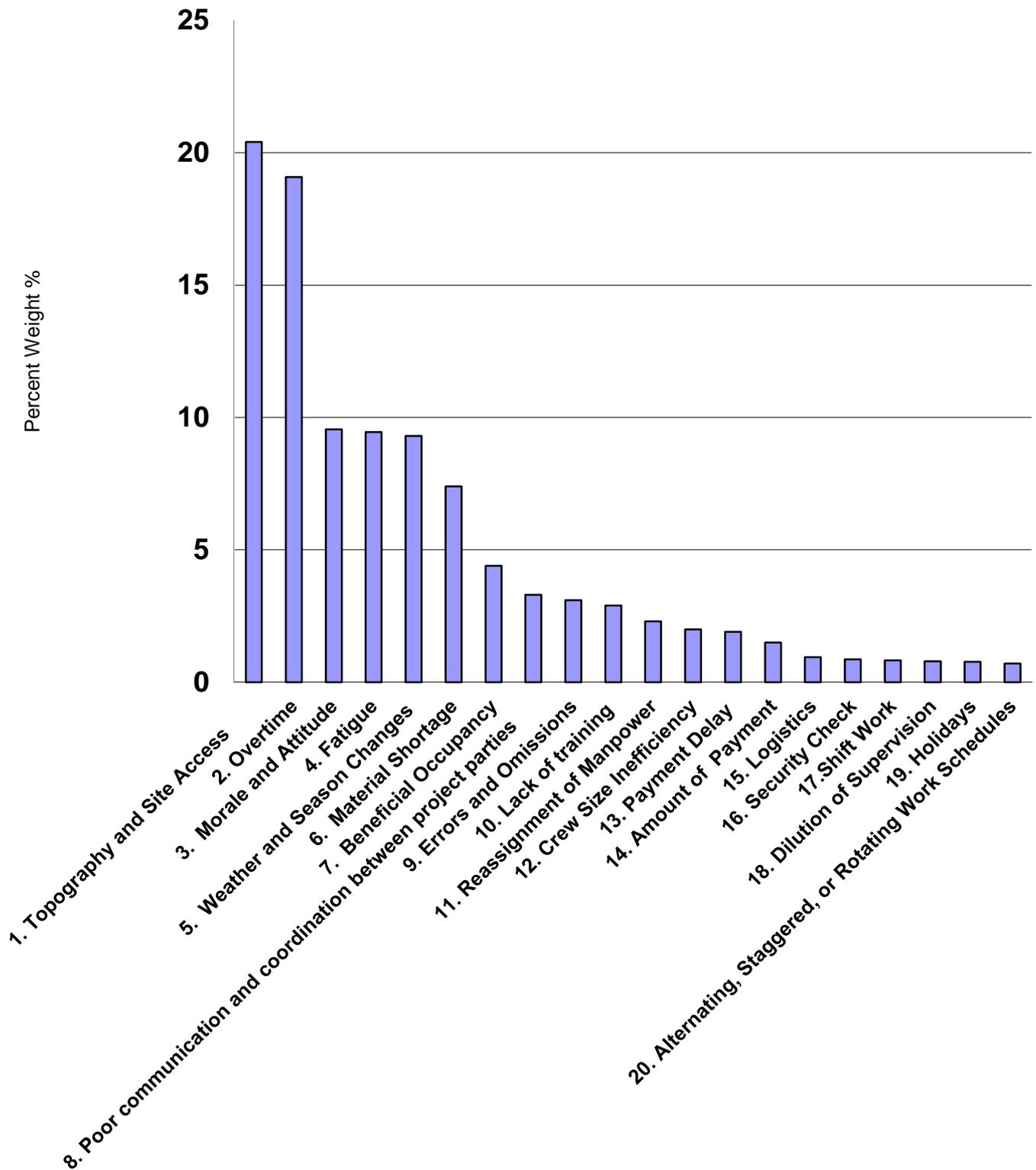


Figure 1. Factors Affecting Road Construction Labor Productivity (Bar Chart)

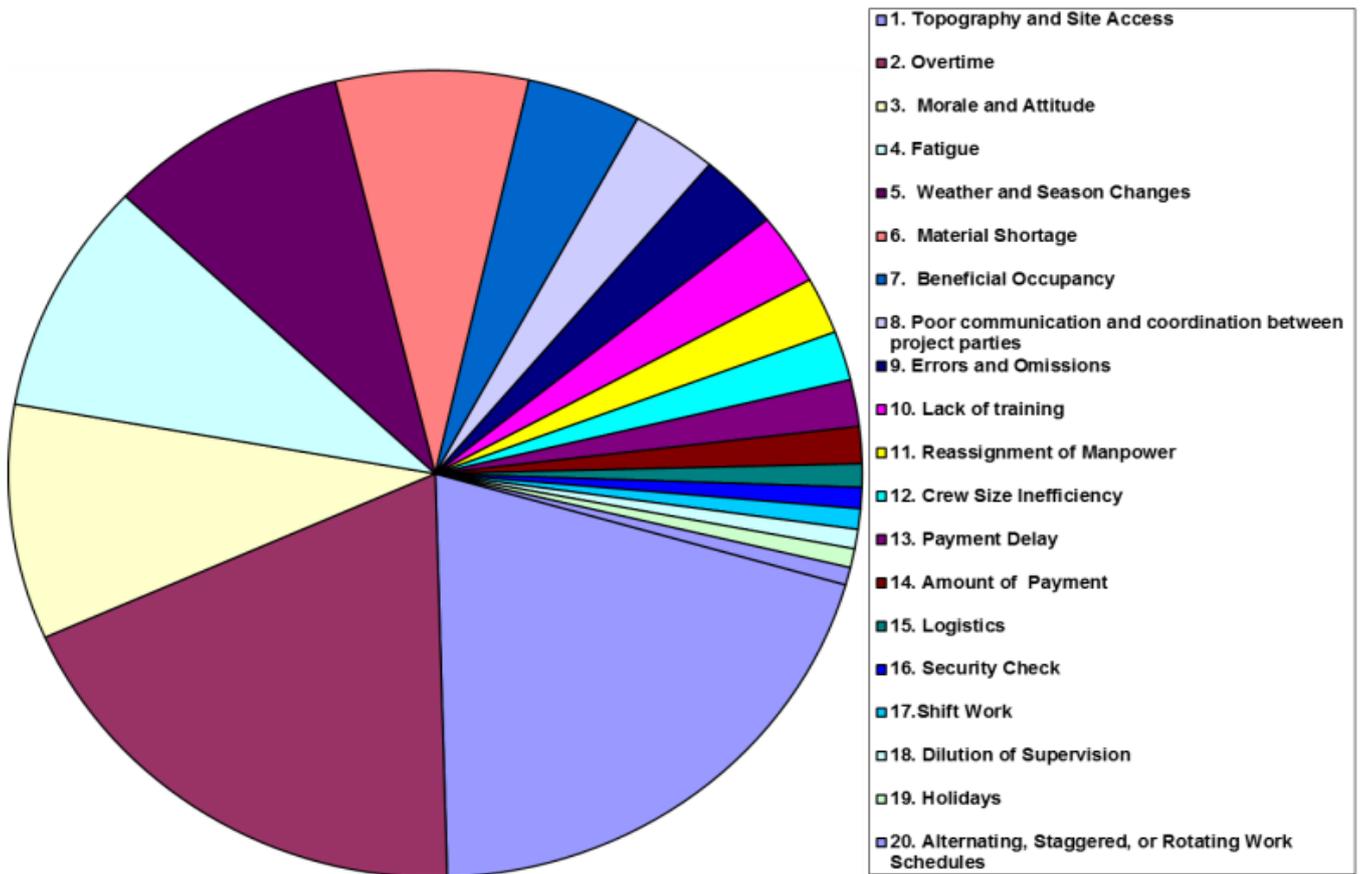


Figure 2. Factors Affecting Road Construction Labor Productivity (Pie Chart)

IX. CONCLUSIONS

The main conclusions drawn from this study are there is no standard definition of productivity and any current misunderstandings about productivity appear to stem from at least nonstandard terminology. It appears that choosing a measure that is appropriate to the purpose is very important. State-of-the-art methods and techniques of productivity measurement are presented.

The key for productivity improvement is not to complete as many tasks as possible or to maximize workload, work output, or work hours without following the work plan. Rather, the key is to focus on maintaining a predictable work flow and thus be able to match the available workload with capacity (work hours). Since work flow variation is significantly correlated with labor productivity performance, the party who caused work flow variation should also be responsible for the reduced productivity. Applying the work flow variation analysis in labor productivity claims can help contractors and owners reach an agreement on who caused productivity losses and who should be responsible for it. Therefore, it can help save time and money.

To improve project performance, variability in labor productivity should be reduced with regard to available workload and capacity (work hours). Variation that affects

labor productivity and should be reduced is defined as the time difference between what was planned and what occurred in terms of task starting times and duration. A set of graphs for factors affecting labor productivity was presented which could help improve labor productivity and projects' performance.

REFERENCES

- [1] P. Dozzi, S. AbouRizk, "Productivity in Construction", Institute for Research in Construction National Research Council Ottawa, Ontario, Canada, 1993
- [2] White Paper, Factors Affecting Construction Labor Productivity; Managing Efficiency in Work Planning, Intergraph Newsletters.
- [3] W. Halligan, A. Demsetz, J. Brown, C. Pace, "Action-Response Model and Loss of Productivity in Construction", Journal of Construction Engineering and Management, ASCE Vol. 120, No. 1, PP. 47-64, 1994.
- [4] W. Peterson, T. Scullion, "Information Systems for Road Management" Draft Guidelines on System Design and Data Issues, Washington, DC, pp. 6, 1990

- [5] R. Logcher, W. Collins, "Management Impacts on Labor Productivity", *Journal of the Construction Division, ASCE* Vol. 104-CO4, PP. 447-461, 1978
- [6] R. Thomas, W. Maloney, R. Malcolm, W. Horner, G. Smith, V. Handa, S. Sanders, "Modeling Construction Labor Productivity", *Journal of Construction Engineering and Management, ASCE* Vol. 116, No. 4, PP. 705-726, 1990
- [7] M. Shehata, K. El-Gohary, "Towards Improving Construction Labor Productivity and Projects", *Performance Alexandria Engineering Journal*, Vol. 50, PP. 321-330, 2011
- [8] S. Karimian, "Improving Productivity in Road Pavement, Maintenance, and Rehabilitation in New Zealand", *Master Thesis, Massy University, Albany, New Zealand*, 2014
- [9] Conference Proceedings, "Research on the Construction and Development of New Countryside in Shaanxi", Hui'ai Yuan, Shengjun Zhang, 1st International Symposium on Education, Culture and Social Sciences (ECSS 2019), pp: 2352-5398, <https://doi.org/10.2991/ecss-19.2019.91>
- [10] P. Soparat, N. Suksuwan, S. Trangkanont, "The Integrated Appraisal Framework of Rural Road Improvement Projects", *Engineering Journal*, Vol. 23(3), PP.117-140, 2019.
- [11] J. Li, Z. Huang, "On the Way to the Silk Road: Trade, Investment, and Finance in Emerging Economies", PP. 3131-3133, 2019.
- [12] S. Ganesan, "Employment, technology and construction development: With case studies in Asia and China". *Routledge, eBook ISBN9781315186115*, 2019.
- [13] M. Momade, M. Hainin, "Identifying motivational and demotivational productivity factors in Qatar construction projects", *Engineering, Technology & Applied Science Research*, Vol. 9(2), PP.3945-3948, 2019.
- [14] M. Munir, M. Zaheer, M. Haider, M. Rafique, M. Rasool, M. Amjad, "Problems and Barriers Affecting Total Productive Maintenance Implementation. Engineering", *Technology & Applied Science Research*, Vol. 9(5), PP. 4818-4823, 2019.