SELECTING THE BEST STRATEGY OF LABOR PRODUCTIVITY IMPROVEMENT IN TEHRAN GRADE1-3 CONSTRUCTION CONTRACTOR COMPANIES BY APPLYING ANALYTIC HIERARCHY PROCESS AND STATISTICAL ANALYSIS OF EFFECTIVE FACTORS ON LABOR PRODUCTIVITY

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ABSTRACT

Productivity of labor working in construction projects is one of the most considerable subjects in project management. Increase in productivity level plays a major role in project success and securing the objectives of it. The aim of this paper is to develop strategies for enhancing labor productivity level. By reviewing the related productivity literature and using the Delphi method, questionary for data gathering was developed. Related questionnaires have been distributed among grade 1-3 construction contractor companies in Tehran. People asked to identify and grouping effective factors on labor productivity were selected from site supervisors, managers and superintendent. In next stage, by utilizing data acquired from survey questionnaires, descriptive and deductive statistical analyses were accomplished. On the strength of the most important identified factors, Strategies for labor productivity development have been developed by expert group cooperation. Prioritizing and selecting the superlative strategy were accomplished by applying analytic hierarchy process. Moreover, Condition and weight data of effective factors of contractors' projects were used in analytic hierarchy process.

In the end, the proposed methodology was evaluated through the case study among construction contractor companies in Tehran.

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Keywords: Human Resource Management, Productivity, Analytical Hierarchy Process (AHP), Statistical Analysis, Sensitivity Analysis.

1. Introduction

The most important issue that has attracted project managers' attention is how to conduct the projects successfully. It should be considered that success of projects is dependent on access to desired level of productivity. Major issue in this context is increase of human resources productivity level.

1.1 Productivity history

Human participation, during historical evolution and development of societies, has faced qualitative and quantitative changes of human work in production. Industrial development is accomplished relying on two important capitals, physical capital and human capital. Human resources have two important roles in production and economical development: the role of work as the primary production factor, human role as a factor upper than work and other production actors. Low individual productivity in production firms leads to paying more attention to human forces development. The first step in promoting productivity is improving productivity in individual level. In project management body of knowledge (PMBOK) in the chapter titled "human resource management", employed human force productivity in project is pointed out.

1.2 Productivity definition

In a simple definition, productivity includes output rate per each unit of input which is used as a criterion for economic health. In fact, human resource is one of the most valuable capitals of construction firms so improving its performance could lead to increase of productivity level [1].

1.3 Comparing human resource productivity in Iran and other countries

Despite expenditure consumed for industry section, active human resource productivity in this section is 40% lower than human resource productivity in national level (national productivity). Productivity average of active human resource in industry section is 2/5 times as much in Africa, twice as much in Asia and 1/5 times as much in Latin America in comparison with Iran human resource productivity average (national productivity) [2].

1.4 Factors influencing productivity

Motivation as a main factor influencing productivity is considered more by researchers; especially positive pressure which leads to behavior change in a desirable manner. Lyn and Alvin (1995) indicated that main motivational factors influencing productivity are project environmental conditions and labor arrangements. In previous researches issues such as fine and encourage plan, paying overtime working, granting leave, etc were considered. Ledford and kochanski (2001) considered performance and job satisfaction of workers as a function of motivation and encouragement of them [3]. Maybe it can be said that in the same way that motivational factors are useful and affective in increasing labor productivity, anti-motivational factors will lead to decrease of productivity level. Anti-motivation originates from situations which lead to lack of satisfaction and disappointment rather than lack of or deficiency in motivational stimuli. Omission of anti-motivations can lead to increase of motivation and is followed by more effort of workers for reaching to goals.(duplication, contraction and crowd in work environment, interference of working groups, access to instruments and tools, delay in inspections, access to materials, lack of head workman's ability). [4]

1.5 Grouping factors influencing productivity

Researchers have applied various categorizations in relation to factors influencing productivity. In each of aforementioned categories, effect of environment dominant in work or project with used categories by

researchers is noticed in a way. In the current research conducted by authors of the current article, primarily effective factors of productivity was considered, evaluated and grouped through measurement and statistical analysis.

1.6 Strategically planning for development of productivity

Strategic management is the flow of decision and activities that result in one or some effective strategies to gain the goals of the company. Three elements are introduced in the process of strategic management includes: Development of strategy, implementation of strategy and control (evaluation) of strategy. The aim of the current research was recognizing most important universal strategies of labor productivity development. Total strategies of current research include: recognizing and grouping effective factors, developing strategies influencing labor productivity on the basis of recognized factors. Recognizing factors influencing productivity and grouping them in previous studies often lacked a managerial approach on the project stage. In most of previous studies, researchers provided productivity development strategies by virtue of important factors in the considered statistical universe without considering special statue of each project. Current research tries to improve strategic insight toward productivity through increasing effect of meeting factors in each project.

2. Methodology

At first we will engage in factor recognition step through review of issue literatures and then applying Delphi method. Firstly, by archival studies, international papers in valid publications related to research subject, main basis of information about theoretical bases and recognizing effective factors of productivity is formed. Then a group of experts with researcher of current collection, recognized, reformed and completed factors. Expert group of contractor company, included individuals such as corporation manager, technical office chairman, workshop supervisor, et al. these people were chosen and questioned according to their role, experiment and knowledge about factors influencing human force productivity.

2.1 Grouping effective factors, according to PMBOK approach in enterprise environmental factors

In grouping factors, researchers have tried to provide obtained factors in the direction of categorization with regard to "enterprise environmental factors" in PMBOK. The difference is that instead of considering group of internal factors and external factors or provided partial grouping in PMBOK, a more effective and update grouping is provided. Subgroups create better cohesion between factors and main groups by making cohesive categorization inside groups.

2.2 Editing labor productivity development strategy

Given to recognized factors and considering provided grouping in previous section, now strategies toward development of employed labor productivity in construction projects should be edited. In order for reaching this goal, questionnaires for introducing strategies were distributed among professionals. They were asked to present their productivity development strategies by considering factors influencing productivity and performed grouping. After gathering questionnaires obtained strategies were categorized in 3 following groups: -Strategies for developing planning and controlling project, -Strategies for developing human resource in executive organization, -Strategies for financial management development in projects. Each of these groups includes groups of factors influencing productivity which are approved by professionals in part of recognizing and grouping factors. After this step, it's time for prioritizing productivity development strategies by hierarchical analysis method.

2.3 Application of AHP in measuring importance of factors and prioritizing productivity development strategies on the stage of industry under research

2.3.1 Analytic Hierarchy Process (AHP)

Decision making is one of the main characteristics of human being and every individual has to make several decisions within his life time. Contrary to some decisions, a number of them have significant importance. Analytical Hierarchy Process developed by Thomas L. Saaty in 1980 is a method to solve the problems of multicriteria decision making in which both qualitative and quantitative criteria can be considered. This is because it has been designed in a way that adopts human mind and nature. This procedure includes a number of individual judgments weighting in a rational way. According to the Miller's Law, an individual normally can compare only 7±2 items at the same time. AHP improves the quality of decision making through providing pairwise comparison between criteria and alternatives. AHP, in fact, creates the chance of searching and evaluating the cause and effect relationship between goal, criteria, subcriteria and alternatives using breaking down the structure of the problem [5]. The general procedure of Analytical Hierarchy Process can be summarized as follows [6]: Developing the decision tree or hierarchy structure, making pair wise comparison of criteria and, forming matrix of pair wise comparison, Comparing alternatives in relation to different criteria and forming matrix of pair wise comparison. Determination of inconsistency index of matrices obtained from the two previous steps. Saaty suggested the allowable limit to be 0.1.,Normalizing the obtained matrices from previous steps, Calculating the row average of normalized matrices, Forming decision making matrix.

2.3.2 Application of AHP in measuring importance of factors and prioritizing productivity development

In the current research after recognizing most important factors influencing labor productivity and grouping them, statistical analysis was performed and most important factors were recognized. Productivity development strategies in hierarchical structure are chosen with regard to each of these compared factors and finally best development strategy is selected. It should be mentioned that selected strategy in this step is merely according to industry under consideration (construction industry) and is not related to a specific project. Tree diagram of most important groups and their subset factors and development strategies are indicated in table.1. Pair comparison between factors is only performed in their related group but our pair comparison between strategies is performed between all factors.

2.4 Providing a method for selecting preferable strategy of labor productivity development according to factor state in different projects

Obtained priority for strategies of construction is general and is not related to a specific project. Since in different projects factor influencing productivity have different conditions, obtained priority is not true in all cases. On the other word, preferable strategy of industry in the direction of promoting labor productivity is not preferable strategy in all construction projects and changing strategy according to factor state in projects is needed. Method developed for abovementioned problem in this research is according to weight correction of factors influencing productivity according to factor state in different projects. Total procedure of method includes following steps: -W(i): calculating weight vector of factors influencing labor productivity in considered industry (here construction industry), -C(i): calculating weight vector of factors influencing labor productivity in a special project (state of each project is according to percent of factor satisfaction in that project), - W_m(i): calculating reformed weight vector of factors influencing labor productivity according to state of factors in a special project (aforementioned vector is result of product and normalizing vectors, W(i) and C(i), - M (i×j) finding weight matrix of strategies priority according to each of effective factors (aforementioned matrix rank is according to number of strategies and factors), - Final prioritizing strategies of productivity development in a special project are resulted from multiplication of M in vector W_m Finally by through applying suggested method, it was allowed to select preferable strategy in construction industry and according to special condition of each project.

3. Applying the proposed method in case study project

3.1 Properties of case study project

Case study was performed for the project of roofing a freeway in Tehran conducted in 36 months. Sum of this project contract has been 150 billion Rials (approximately 15 million dollars) which was paid periodically. Project was conducted by first grade contractor by EPC.

3.2 Preferable strategies for labor productivity development related to construction industry

Given to developed structure in table.1, importance of groups and factors and sub factors in each group, ratio of compared factor was obtained through pair wise comparison. Obtained importance for factors is related to construction industry (topic under study in conducted research). In the last level, Priority of strategies was obtained through pair wise comparison of them as compared to each conducted factors and finally through synthesize of obtained weights in different levels of developed hierarchical structure and final priority of strategies. Given to this matter that in most pair wise comparison matrix number of factors is less than 3, inconsistency is maintained less than 0.05. Overall inconsistency related to developed structure for strategy prioritizing was obtained equal to 0.0a or 1%. Results of weights and strategy prioritizing and effective factors are shown in table 1.

3.3 Preferable strategy for labor productivity development related to case study project

In this step we reform effective factors weights according to their state in considered project. In this step according to judgment of employed people in project factor state vector C (i) was obtained and from product of this vector in effective factor weight vector in previous step W (i) effective factors according to estimated amount of factors in studied project was gained. Finally weights related to strategies prioritizing according to steps 4 and 5 in part 2.4 of article was obtained. (Table 1)

4. Discussion and conclusion

In the current research we have tried to select strategies for labor productivity development in the project of prioritizing and preferable strategy. After determining preferable strategy in project we can recognize weakness factor in projects and executing strategies in the shape of executive programs in project executing organization allows for promoting productivity in labor level. Promoting productivity in individual level leads to improvement of project performance. So in conducted research factors influencing productivity at individual level is recognized and grouped. Most important strategies of development were edited according to factors and groups. Through using analytic hierarchy process, strategy priority was determined and in fact industry priorities were distinguished. In the following for considering special condition of factors in different projects and selecting best strategies specialized for a project, a new method is suggested which selected and prioritized strategies by considering factors states in projects. Results of applying method are shown in table1. As determined by results, main priority in industry (construction industry) is strategy for developing planning and controlling in projects and after that strategies related to human resource and financial management are placed. But since in case study project factors state has affected weights and importance of strategy for planning and control became more than two other groups and importance of financial management strategy has reached its minimum, performed comparison can affect our focus on priority of applying strategy in project. If a project is considered that factors related to human resource management in that project have disorganized condition, it is highly probable that our preferable strategy would be human resource strategy and this is the issue that requires consideration in another case study and consideration for effectiveness of applying strategies in a practical project.

Table 1. Relative importance of effective factors and effective groups and strategies

Effective Groups	Weights	Effective Subgroups	Weights	Effective Factors on Labor Productivity	W	C	Wm	Improvement Strategies	Industry Weights	Project Weights
X1- Organization Related Factors	0.571	Y1- Human Resource Management	0.387	Z1- Labor Education	0.097	0.0397	0.0777	Planning & Project Control	0.481	0.556
				Z2,3- Job Safety & Satisfaction	0.048	0.0317	0.0308			
				Z6- Job Promotion	0.022	0.0476	0.0212			
				Z7- Technical Prequalification Before Employment	0.054	0.0397	0.0433			
		Y2- Financial Management	0.16	Z9- Financial Incentives & Remunerations	0.014	0.0159	0.0045			
				Z10- Salary & Wage Rate	0.055	0.0238	0.0264			
				Z11- Timely Payment	0.028	0.0159	0.009			
		Y3- Technical Management	0.443	Z12- Efficient Interaction with Employer & Consultant	0.031	0.0635	0.0397			
				Z13- Project Planning & Control	0.164	0.0635	0.2102			
				Z15- Labor Safety & Health	0.058	0.0714	0.0836	Executive Organization Human Resource	0.386	0.344
X2- Environment Related Factors	0.143	Y4- Nonphysical Environmental Condition	0.667	Z18- Communication with other labors	0.008	0.0317	0.0051			
				Z19- Permanent or Temporary State of Job	0.028	0.0238	0.0135			
				Z20- Increase of Shift Work	0.046	0.0238	0.0221			
				Z22- Membership in Unions & Supporting Organizations	0.013	0.0159	0.0042			
		Y5- Physical Environmental Condition	0.333	Z23- Weather Condition	0.006	0.0714	0.0087			
				Z24- Welfare Facilities & Services	0.027	0.0476	0.026			
				Z26- Distance from Living Location	0.015	0.0794	0.024	Project Financial Management	0.133	0.1
X3- Project Related Factors	0.286	Y6- Job Specifications	0.667	Z27- Shop Drawings & Technical Specifications Completeness	0.038	0.0476	0.0365			
				Z29- Reworks	0.076	0.0714	0.1096			
				Z30- Jobsite Congestion & Disruption	0.076	0.0635	0.0974			
		Y7- Labor Specifications	0.333	Z34- Speciality in the Activity Field	0.063	0.0556	0.0707			
				Z35- Education Stand Related to Work	0.032	0.0556	0.0359			

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