



Studying potential use of Automation products for Infrastructure Construction in Indian context

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Abstract- *Indian infrastructure construction industry has large potential as US\$1trillion is the targeted investment during 12th Five year plan. Hence in this paper authors try to find the potential use of automation products in infrastructure Construction in India. During study 15 various activities of construction are studied for the use of various automation products i.e. manually controlled machines; tele controlled machines; computer controlled machines and cognitive robots. Results show that India has large potential for use of automation products and Indian firms are ready for use of automated products.*

Keywords: *Infrastructure construction, automation products, India*

I. Introduction

Infrastructure construction is at boom in India and as per India Infrastructure report [4] SWOT analysis shows main opportunity for India infrastructure industry in the 12th Five year plan a were target of investment of US\$1trillion. However main weakness observed is the limited use of modern technological equipments, plant and machinery along with a shortage of skilled labour and engineers which shows an urgent need for automation and use of Robotics in India. In this paper, the main objective is to study the potential use of Automation products for infrastructure construction in detail. Literature review carried out to find various levels of automation products along with various types of robots developed. Then a list of activities is identified in which current status of use of automation products is considered. Results of survey of 74 respondent shows that use of automation products in India has a large potential as most of activities can be automated.

II. Literature Review

A. Type of automation products:

Reference [13] considered sophistication of technology application and defined mechanization, automation and robotics. Japan industrial robot association (JIRA) defines robots as per degree of autonomy as: Manual handling devices; Fixed sequence robots; Variable sequence robots; Playback robots; Numerically controlled robot; Intelligent robots [19]. Reference [21] considered a mechanization graph in which energy and control provided by equipment and various mechanization phases are observed and results showed that mechanization phases can be represented as a chain in which traditional method can be mechanized in phases as from hand tools; manually controlled device; Tele-controlled devices (remote control devices); pre programmed devices (computer control devices); cognitive robots. These phases are similar to Japan Industrial Robot Association (JIRA). Hence in this paper robots are considered with four generations as manually controlled machine, tele-controlled machines, computer controlled machines and cognitive robots.

B. Use of various automation products in Construction activities:

An automation of PHC pile head grinding and crushing works [9]; ARTISAN, is a radiation tolerant tele-operator robot and has a heavy duty manipulator system designed by RWE NUKEM Limited in Germany and are specifically designed for nuclear decommissioning, Remotely Controlled Machine For Biological Shield Concrete [16]; "The double arm working machine", that is suitable for demolition and scrap-processing [17]. Navigation Type surveying system using real-time kinematic GPS [18]; remotely controlled breakers, backhoes, dumper trucks are used for removing volcanic debris with the help of GPS systems in Mt. Unzen Fugendake; a robots system controlled by laser is used to measure three dimensional topography of an area even at night time also [5].

Robotic excavator [14]; The tele-operation system for the excavator with movements of a human arm has been developed so that unskilled operators can manipulate small sized excavators easily, intuitively and safely from a distance [8]; In intelligent excavator for hydraulic mobile machine the boom and the bucket of the machine are normally controlled with a joystick. Horizontal movement of the joystick controls the bucket and vertical

movement controls the boom [20]; ROVO Caisson method for automating excavation, soil transfer and soil discharging operations in Pneumatic Caisson; Tele-earthwork system; [18].

Placer boomers for concreting piers; Slip formwork [1]; Computer controlled mobile concrete distributor; simplified Distributor "DB ROBO"; automatic concrete distribution system with tower crane applications to super high-rise building; stabilator shortcreting system, Robot 7500 on truck chassis or rail car; automatic concrete transportation system in dam construction works; [18]; Concrete floor screeding robots "SCREED ROBO"; concrete-slab finishing robot; floor trowelling robot; TAPS (Tobishima auto Level Pantograph Slip form) method [18]. New mini crane from Japan can ride on the Van, can go up and down the stair "KALCATT" (LM15-1); material handling system for interior finishes; light weight manipulator; autonomous truck system; automatically adjusting system of plumbing structural steel column; Column welding robot; "T-UP" building construction method; [18].

An automated pavement crack sealer (APCS) can be used for crack sealing in pavements [11]; A multipurpose road pavement repairing machine (ROADMOTO) is equipped with asphalt milling drum and two asphalt spreaders [7]; SAKAI ER501F Road Profile Cutter equipped with ACCS (Automatic Cutter control system); Road Robot-fully automatic Road paver; robot asphalt finisher [18].

A model for the application of imaging to the automation of infrastructure maintenance for better safety, productivity and quality is developed. The model incorporates: a domain structure, human-machine interaction, processes including machine vision, sensor data fusion, automated task planning, and control loops, and graphical representation and visualization [10].

The semi-automated shot creating robot prototype is a hydraulic spraying arm model for placing shotcrete in tunneling and mining operations and the robot arm has six degrees of freedoms and is remotely controlled by an operator using a control box with six joysticks and three buttons on the board [2]; Automated shotcrete equipment which has Wet spraying system, Practical shotcrete spraying is used in Paghuashan tunnel [12]. Service robot for Façade cleaning and tasks of Inspection and Maintenance; surface preparation system "BIBER"; Exterior wall tile inspection robot; Ultra compact inspection robot; Climbing robot RoSy II; Vacuum-Adhering and Self-Travelling system, Abrasive Blasting Robot; Automatic Cleaning system for the under carriage of construction machine "YC300W-1" [18].

Many automated girder erection methods can be used in heavy traffic i.e. using a transfer car; a transfer car equipped with air casters; and by unfolding a folded traffic lane section after erection to reduce traffic congestion. [6]. Automatically adjusting system of plumbing structural steel column TO-Plumb Navi; Column welding robot by Shimizu Corporation and Mitsubishi Heavy Industry Ltd [18]. Pavement lane painting operations robot [22]; The robotic bridge paint removal (RBPR) system that can increase the safety of workers and public as well protect the natural environment against toxic pollution [15].

Thus Literature review shown that various types of robots are developed in following activities in construction which includes: Demolition; survey; Excavation; foundation construction; Pier construction; Hoist and installation; Launching of girders; Transportation; formwork; concreting; finishing of pavement surface; maintenance and inspection; tunneling; welding in steel structure; and painting.

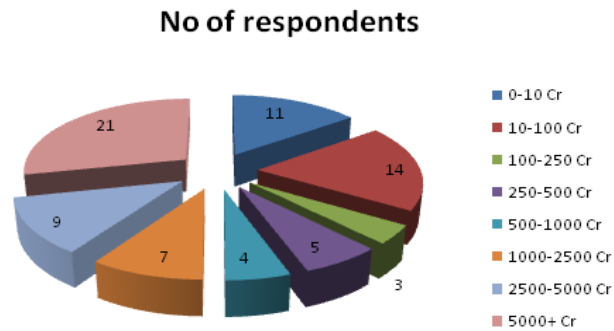
III. Research Methodology

Purposive sampling, especially snowball sampling is used as firms using automation are having rare population. Personal interview method is used for data collection. Total 74 respondents having different positions in organizations are considered. Sample includes 24.3% top managers; 48.6% project managers and 27% users. These respondents are also divided as per turnover of firms in which they are working and division of firms are 0-10Cr; 10-100 Cr; 100-250 Cr; 250-500 Cr; 500-1000 Cr; 1000-2500; 2500-5000 Cr; 5000+ Cr. All respondents are asked which type of robots their company uses i.e. manually controlled machine, tele-controlled machines, computer controlled machines and cognitive robots in various construction activities i.e. Demolition; survey; Excavation; foundation construction; Pier construction; Hoist and installation; Launching of girders; Transportation; formwork; concreting; finishing of pavement surface; maintenance and inspection; tunneling; welding in steel structure; and painting.

IV. Data Analysis

Respondent's details as per turnover of firms in which they are working are shown in fig 1. Use of various types of automation products are shown in fig 2. Activity wise results of use of automation products in various activities show that all activities use all four types of automation products. Robots use is found more in welding in steel members (5.6%); maintenance and inspection (4.21%); and tunneling (3.9%). Use of computer controlled machine is more in concreting (26.28%); finishing of surface of pavement (25.6%); and tunneling (21.57%). Use of tele-operated machines is found more in launching of girder (21.43%); survey (20.59%); and concreting (18.25%).

Figure 1: Respondents details as per Turnover of firms



Use of various types of automate products as per turnover of firms are shown in figure 3. There is one interesting observation that use of robots is more in firms with turnover 10-100 Cr and 5000+ Cr this may be because large firms are more protected during change as they have large budget where as small firms are more opportunistic and consider technology as core competence [3].

Fig 2: Use of various automation products in various construction activities

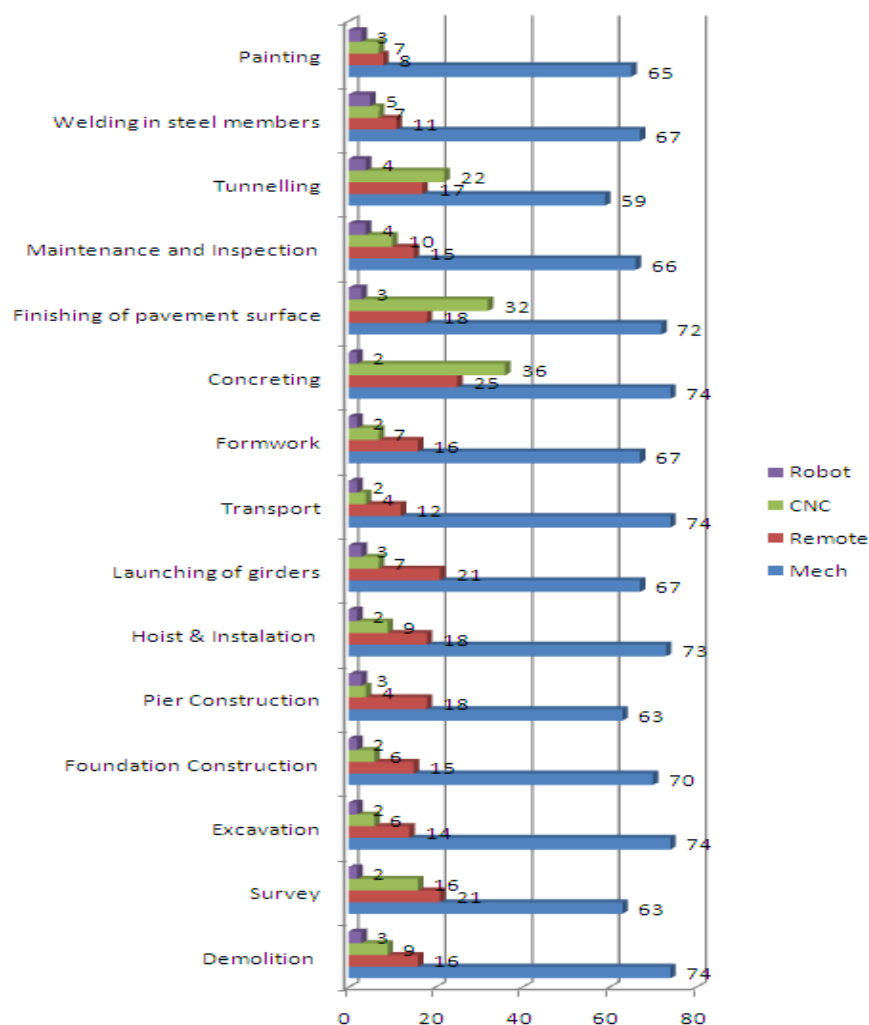
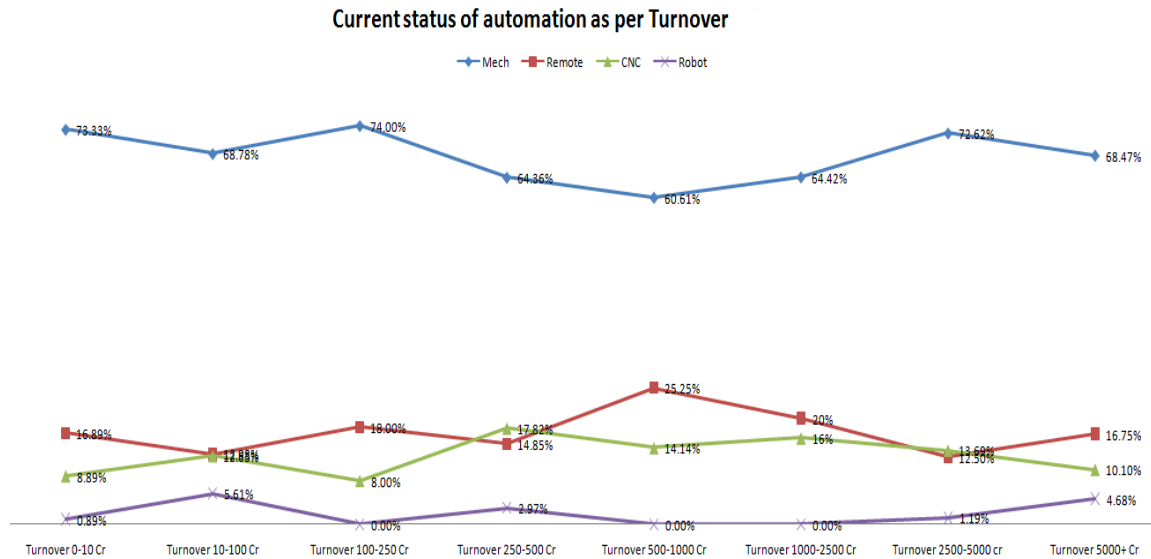


Figure 3 Current uses of automation products as per turnover of firms



V. Conclusions and Recommendations

As the main objective of this study was to find the potential use of automation products in infrastructure construction in India, the results show that there is a very large potential for automation. As all type of firm uses 60% or more manually controlled machine which can go to higher automation levels i.e. tele-operated machines, computer controlled machine and cognitive robots. Both small firms and large firms of India have greater potential for adopting automation products.

VI. References

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