

STRATEGIES FOR ENHANCING RESEARCH AND DEVELOPMENT ACTIVITIES IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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Abstract - Research and Development (R&D) activities stimulate growth, sustainability and performance. However, the construction R&D expenditure is in the range of 0.01% - 0.04% of global value addition, compared to 3% - 4% in manufacturing and 2% - 3% in other industries. Thus, this research explores the possible strategies to promote R&D by investigating the perception of innovation, drivers and barriers. 12 experts representing three major sectors: research institutes, construction related academic institutions and large scale contracting organizations were interviewed and their views were analysed using a content analysis. According to more than 70% of participants, the thirst for innovation is yet to be realized by construction organizations and the focus is primarily on cost reduction and profit generation. Expert views reveal that commitment of employees and management is the most prominent aspect to promote R&D activities. Further, the attention given to construction R&D is minimal due to higher cost and invisibility of return on investment within a short period. The findings indicate that lack of collaboration between research institutes and construction organizations to undertake industry driven research, use of conventional industry practices and reluctance to innovation as contributors to minimal R&D in the construction industry. Many participants opined lack of government support as a critical concern to promote R&D. Therefore, this research suggests that developing a culture of innovation and increasing the competition in the market could drive construction R&D.

Keywords: Construction industry, Drivers and Barriers, Strategies, Research and Development

I. INTRODUCTION

Construction industry acts as a prominent player in any country's economy, as it is directly related to the development of infrastructure, industrial facilities and buildings (Myers, 2008). One of the most noteworthy current discussions in the industry is about the significant, favourable impact provided by innovation practices (Jefferson, 2006). Following, Zhang, Skitmore, Wu and Ye (2010) reported that Chinese construction industry invested 1.66% to R&D activities out of the total investment made in 2006, the statistical findings of World Bank Group (2015) confirm that China enjoyed nearly 70% of strong economic growth due to higher expenditure in R&D in year 2011. On the other hand, Dulaimi, Ling, Ofori and Silva (2002) indicated that poor performance in construction industry due to the less attention has given to R&D by organizations.

It is further evidenced that expenditure on construction R&D is minimal in most of the countries. For example, Business enterprise R-D expenditure by industry (2017) indicated that amongst Korea, Israel and Japan, which have the highest gross domestic expenditure on R&D as a percentage of Gross Domestic Production (GDP), only Japan and Korea have R&D expenditure spent on construction industry related activities. However, Wong, Thomas Ng and Chan (2010) express that as per statistics, the highest investment on global construction R&D is spent by Japan which is 3% out of gross receipts of Japanese construction industry. Research findings by Business Enterprise Research and Development (2014,

2017) also point towards the fact that construction industry contribution to economy in United Kingdom (UK) has increased by 45% since year 2013, being the largest industry contributor to economy and only 6% of construction firms engaged in R&D. Zhang et al. (2010) presented that global construction R&D by major organizations was 0.25% of annual revenue in year 2003 globally. On a similar note, Seaden and Manseau (2001) indicated that construction R&D expenditure ranges between 0.01% - 0.40% of value added globally. Authors suggest that reason for poor R&D in construction industry may be due to improper reporting, behaviour of clients, project-based nature in construction and inability to measure innovations properly. CIOB (2007) put forth that unawareness about tax incentives for R&D as the reason for less expenditure by construction firms. Masqood and Finegan (2009) further supported this view stressing that construction firms do not look for mechanisms to embed innovative culture into the core of the organization and merely look for productivity enhancing mechanisms.

In order to obtain productive construction R&D outcomes, Spithoven, Clarysse & Knockaert, (2011) is of opinion that organizations need to employ professionals who possess skills in innovative thinking as it provides a platform for the firms to conquer in R&D. Blayse and Manley (2004) further mentioned that collaborative support provided by educational institutes and contracting organizations is very much important to have rigorous results in construction R&D output. On a similar note, Dulaimi et al. (2002) suggested, having a culture of innovation within construction organizations helps to achieve more productive results, because innovation can occur in many aspects and not only by the number of patents received. Masqood and Finegan (2009) opined the importance of learning and innovative culture in construction firms to achieve greater value for money. As a sound solution to this lack of R&D, Jefferson (2006) stresses the need of performance measurement of the prevailing R&D levels in China.

In the Sri Lankan context, Wickramasinghe (2005) indicated that the numbers of patents applied and received by Sri Lanka are relatively low compared to the other countries. A survey conducted by National Science Foundation (2010) has shown that R&D expenditure by all sectors is 0.11% of GDP in year 2008. Subsequently, Wijesinghe (2013) states that country's Gross Expenditure on R&D (GERD) has dropped to 0.11% in 2008 from 0.21% in 2004. However, Colombage (2014) reveals that 1% increase in R&D helps to increase GDP by 0.3%. Yet,

there is no statistics to represent the status of construction R&D in Sri Lanka. Further, local organizations seem to have less priority and involvement in the subject.

With a view of perception of innovation, this research focus is to develop a culture of innovation in the construction industry of Sri Lanka which will stimulate the growth followed by performance levels of the outputs in construction sector. In order to address this target, the importance and prevailing perception of innovation is identified followed by exploring sectoral R&D improvements and then investigating drivers and barriers to address the aim of the research. The step by step approach of reaching the focus of improving the current perception levels regarding construction R&D is attained as per the research method described below.

II. RESEARCH METHODS

The research adopted an indicative approach, where most of the information emerged from the data collection process itself, rather than the literature survey. A total number of 12 participants representing 03 major construction R&D related institutions, 04 experts from each sector were approached for the data collection.

In order to collect more specific information about the research problem, a semi-structured interviews-based survey was administered where more information was gathered from the respondent by means of open ended questions. Followed by the data collection, data analysis and discussion was done using the NVivo technique as it enables to provide organized and themed views of the collected data. The findings are then used to derive at conclusions and recommendations to decide upon the level of construction R&D perception held by construction industry practitioners of Sri Lanka. These conclusions and recommendations are used to propose strategic mechanisms to implement a culture of innovation followed by addressing the critical need of R&D in the construction industry of Sri Lanka.

H. Profile of Respondents

The research sought views of experts who have exposure and experience in the research activities and construction sector. Semi structured interviews were conducted with 12 experts who have 10-20 years of experience in the research field and construction industry. The limited sample is due to the difficulty in finding construction organizations which engage in R&D intensively and

reaching of saturation level with the repetition of findings from the participants. The subjects were selected based on the position held in the company and the experience gained in the industry. The profile of the respondents who took part in the semi structured interview is presented in Table 1. As given in table, an equal sample was maintained across major categories of participants.

Table 1. Profile of interview participants

| Type of Organization (Nature of work) | Position | Experience (Years) |
|--|---------------------------|--------------------|
| Research Institute (Research Administration) | Director | 17 |
| | Assistant Director | 08 |
| | Executive Officer | 05 |
| | Executive Officer | 16 |
| Academic Institution (Research Supervision) | Research Coordinator | 19 |
| | Research Supervisor | 9 |
| | Research Supervisor | 16 |
| | Research Supervisor | 13 |
| Contracting Company (Construction) | General Manager | 10 |
| | Assistant General Manager | 30 |
| | Director | 14 |
| | Director | 13 |

III. ANALYSIS AND FINDINGS

In an attempt to make interviewees as comfortable as possible about the research focus, a brief introduction was initially given on the subject area. This was explicitly needed for all participants except for the academic researchers as the chosen academics are thorough with both the construction field and the research activities. The findings of the interviews were organized under four main sections: importance of construction R&D, definition of construction R&D, drivers and barriers of the industry towards construction R&D, and strategic mechanisms to improve the status of construction R&D. Under the importance of construction R&D, several sub themes were emerged addressing the critical needs of the Sri Lankan construction industry.

I. Importance of Construction R&D

Surprisingly, not many respondents have given their views on the importance of construction R&D to the Sri Lankan construction industry as evidenced. One major reason for this could be the lack of awareness held by the respondents about the critical need of R&D which will assist for the advancement of the industry with strategic thinking. Rather, majority of the experts held the idea that R&D is not the earliest need of the Sri Lankan construction industry and having mannerisms to develop cost effective and higher return on investments generated within a shorter period of time becomes more attention seeking attributes.

Out of seven (07) interviewees who provided views on the importance of construction R&D, majority indicated that cost minimization and performance improvement of the construction R&D activities as the prime concern of the practitioners. According to them, this has evolved due to the immense requirement in the construction field, to achieve cost and performance as essentials. It is interesting to note that this finding is in line with Maqsood and Finegan (2009) who suggested that construction firms merely look for productivity enhancing mechanisms rather than strategic development attributes.

The need of cost minimization is further confirmed as majority of participants referred the importance of construction R&D to be basically target oriented rather than innovation based. This perception on construction R&D is of the similar view of Yitmen (2007) as the author has defined innovation to be the finding of new methodologies to undertake the same task at a lesser cost, improved efficiency and performance. The findings confirm the profit-oriented nature of construction industry as the focus is yet on cost cutting and performance enhancing mechanisms rather than meeting sustainability driven new innovations. This is in line with the statistical findings of CIOB (2007) which reveals that many firms in the construction industry are not aware on the major tax incentive provided for R&D activities and hence they simply plan on achieving profits via the traditional construction methods.

The results of this study did not show any significant connection to the productivity-based importance of construction R&D. It is somewhat surprising that only very few participants noted the need of productivity and sustainability when it comes to the importance of construction R&D. A possible explanation for this result is the lack of need and criticality given on construction R&D

activities by majority of the construction practitioners in the country. The study of Dulaimi et al., (2002) also confirms this view where innovation process is essential for the establishment of higher performance levels in the Singapore construction industry. It is proven with the findings and analysis results, as majority of the participants have stressed about the performance-based advantages created by construction R&D practices and not on the sustainability-based returns.

J. Definition of Construction R&D

The next section of the interview survey sought, participants' views in terms of industry practice on construction R&D pertaining to the definition provided by Farrow, Holley & Burt, (2011). The definition classifies construction R&D on the four major elements of manpower and organizational development, management methodologies, innovations in construction methods and construction dynamics. All participants have given much attention in addressing these elements and it is evidenced that majority of the views have occurred in relation to manpower and organizations along with construction dynamics. The minimum amount of references is visible for management methodologies. Lack of understanding about the suitable management methodologies specifically relating to establishment of construction R&D in Sri Lanka can be a reason for this result.

Under manpower and organizational development 3 sub themes were emerged as employee commitment, management commitment, and job security. When it comes to employee commitment, participants were of opinion that financial and non-financial motivational factors were essential to enhance the commitment levels of the human resource of the organization. It was opined in relation to the investments made to develop interest of innovation among employees working in construction sector of Sri Lanka as it would lead to direct involvement in R&D practices. Similarly, in terms of management methodology elements of the definition, themes suggested to have adaptations from other countries, other industries have new process of developments to increase the prevailing construction R&D levels in Sri Lanka. Therefore, this refers to the benchmarking activities that can be carried out to upgrade the present situation of construction industry related research activities and innovative processes in Sri Lanka to the next level. Hence, many inputs can be taken from the R&D based progressive actions like Japan, China, Korea and Israel as identified earlier in the literature synthesis.

Under the third element of the definition, innovations in construction, 4 sub themes came in to light as shown in the cognitive map in Figure 2 below. Undertaking construction innovations as new product developments, innovative practices taken place at the site level, getting patents, and innovations done due to external forces such as green building requirements are these sub-themes. Majority of the participants were with the opinion that even though there are minor level innovations taken place at site level, these do not see the day light in a more recognized manner due to the lack of documentation and the poor level of appreciation made by the management.

Finally, under construction dynamics, almost all the participants gave their views on the critical need of the government involvement in the means of financial incentives, policy making, proper system development and also tax allowances provision for construction R&D. Hence almost all the requirements pertaining to the development of a culture of innovation lead to the fact that manpower and organizational commitment play a significant role in promoting R&D in the construction industry of Sri Lanka.

K. Drivers and Barriers for R&D in the Industry

The next step of the survey involved seeking views on drivers and barriers possessed by the Sri Lankan construction industry with respect to R&D. The lack of a critical need to address innovation and R&D was found as the most crucial barrier. Adding up to the same, many expressed the view that the prevailing infrastructure levels and technological enhancements in terms of lab facilities and similar attributes are not sufficient to improve the R&D of construction industry further. It was known that many researchers were hesitant to carry out their work up to the next level due to the heavy cost which may incur to get the foreign laboratory assistance in the R&D works. On the other hand, participants opined that the level of competition in the market will lead to drive construction R&D to a much-recognized higher status from where it is now. The development of the above identified barriers in a positive approach will essentially act as drivers of the Sri Lankan construction R&D.

L. Strategic Mechanisms to Improve R&D

Finally, the ideas regarding prevailing construction R&D status of Sri Lanka were evaluated to come up with strategic mechanisms which will enhance the culture of innovation in the country and the construction industry

per say. Under this target attainment, it was revealed that, it is essential to focus on financial availability in a rigorous manner due to the heavy investment requirement for R&D activities. Further, a substantial attention was needed on the involvement made by human resource in implementing a culture of innovation within organizations. These factors along with the other findings are mainly focussed on developing strategic mechanisms to improve construction R&D in Sri Lanka as shown in Figure 1.



Figure 2. Cognitive map of research findings

IV. DISCUSSION

Analysis of collected data indicates the importance of R&D for the betterment of the construction industry of Sri Lanka similar to the research findings of Wong et al., (2010), which drives towards the same fact in the perspective of Japanese construction industry. Although the criticality and the benefits of innovative practices are known to the industry practitioners, a culture of innovation is not yet developed within the Sri Lankan construction industry. An implication of this possibility is that construction R&D can be made a trigger factor in the Sri Lankan construction industry with stimulations given through many other factors such as government involvement and management commitment in each of the contracting organizations.

Further, the empirical findings of this study provide a significant insight on the involvement made by the government as a statutory body and the policy making institute. The finding is confirmed by the research result of Blayse and Manly (2004) where the collaboration of research institutes, academia and construction practitioners helps in undertaking more focussed research works. The results of the study indicate that, as the main governing body of the country, the involvement and the

attention made by the Sri Lankan government to advance the levels of construction R&D should be improved and so that the strategic mechanisms could be implemented. The findings reveal the critical need of the financial incentives provided to contracting organizations and the strong interference to be made by the regulatory bodies specialized in construction R&D activities.

Taken together, these results suggest that only a minority of the Sri Lankan construction organizations are willing to engage in construction R&D activities in a prominent and an effective manner. Therefore, a trigger factor to stimulate innovations within the industry will be the motivation given to employees to engage in new findings. These motivational factors can be either monetary or non-monetary. The implication of this is the possibility of initiating innovations even from the site levels and then moving it upwards the organizational structure. The study has confirmed the findings of Spithoven et al. (2011), which suggests the bottom-up approach of construction R&D which is initiated by the lower level employees of the construction company. The most obvious finding to emerge from this study is the impact that can be made by the management, which needs to be practiced with severe seriousness to get greater value addition by R&D in organizations.

Moreover, the research has shown the many drivers and barriers which cause for the prevailing situation of construction R&D in local construction industry. Investigations made on the drivers which thrive the industry to the next level reveals that R&D is heavily based on the market competition and the culture of innovation. On the other hand, there are many barriers which cause for the lag, as the local construction industry is still using many traditional practices and is not able to embrace innovation due to the lack of technological infrastructure availability. This implies that the construction industry has a greater potential of adding value to the country's economy addressing the identified barriers as specified by Seaden and Manseau (2001) as well. Once the barriers of R&D are eradicated up to a considerable state, the prevailing perception on a culture of innovation can be changed within the mindset of construction industry practitioners of Sri Lanka. The same will cause for economic boost in terms of industry development occurred via the use of innovation and R&D.

The study implicates the critical need of bridging the gap between universities and the construction industry, so that the construction industry professionals could

make use of the tremendous amount of research work carried out annually. One of the best practices is doing so would be to carry out research to address the critical industrial needs. The research institutes could facilitate by providing the support of mediation with laboratory facilities while the contracting organizations can enhance the commercialization and the marketability of new developments. The practical needs of the contracting organizations in the industrial approach can be communicated to the research institutes and academic institutions to engage in more focussed and result oriented construction R&D activities. This would help to improve the prevailing level of construction R&D and thereby meet higher standards leading to cost benefits and profit generating mechanisms.

Another finding of the study is that innovations taking place in construction sites are not given appreciations and so that it could be repeated and improved in future projects. Hence documenting new systems and process improvements to achieve innovation is found as an action that is doable with minimal inputs and within a short-run of the organizations. However, it is essential to have management commitment to implement any of these strategic mechanisms. Such attention given to advance the current construction R&D levels will make sure the economic growth of the country to be higher as per the statistical findings of Colombage (2014). In addition, the study recommends that the Sri Lankan government takes upper hand in making financial backups for research work as it could boost the R&D performance levels in the construction industry and thereby improve the construction sector as well as economic performance.

V. CONCLUSION

The study has found that generally, R&D perks to be a paramount requirement to achieve excellence in the industry mainly in the long-run rather than the short run. The results of the study indicate that industry practitioners are more concerned about cost minimization and performance achievement along with targets, rather than R&D initiatives. Further, the present study contributes additional evidence that suggests the sectoral improvements in construction R&D to be achieved mainly through manpower and organizational development. The results of the research on the importance of human resource and the need of government involvement assist in our understanding in the role of management and the human resource of construction organizations. Manpower and organizational development is the most

dominant sector of the construction R&D. Hence in order to improve the prevailing levels of construction R&D, critical attention needs to be given on human resource. Such involvement of human resource can be carried out by developing a culture of innovation within construction organizations of the country.

The availability of initiatives regarding innovative management methodologies (cost engineering, planning and scheduling) and innovations in construction methods by means of patent applications (prefabrication and standardization) are relatively scarce in the Sri Lankan construction industry. Therefore, focussing on manpower and organizational development (education and training, evaluation of management productivity) and construction dynamics (the most appropriate method to allocate resources by economic modelling, forecasting and environment related policy making) are found as the best approaches to improve the current levels of construction R&D in Sri Lanka.

Although the construction sector has made comparatively less inputs to the R&D attributes, there are no substantial developments made by the already established innovations of other sectors as well. Therefore, taken together, the result enhances the understanding of the prevailing levels of construction R&D, as it is not a critical need at the very moment. Yet, subsequently, times and situations will be of such that the traditional methods used in the Sri Lankan construction sector to be evolved to match the market needs and global needs. By that time, the necessary strategic mechanisms must be implemented to achieve the success in construction R&D activities in a much fruitful manner.

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