Abstract: The importance of knowledge innovation for gaining competitive advantage is widely accepted. The authors exhibit the unique and necessity for construction project innovation in China. Distinguish between intrinsic and extrinsic driven forms of project knowledge; they argue that the motivation for multi-subjects is crucial for generating and transferring implicit and explicit knowledge. They analyze various dynamic mechanism and motivational devices with respect to their suitability for making use of explicit and implicit knowledge. In so doing, they particularly emphasize that project manager should organize suitable forms to enhance knowledge innovation and transfer by balanced motivation modes.

1. Introduction

Nowadays, the market competition has been all-time fierce, and it would be impossible for any industry or enterprise to survive or develop in a close and autonomous environment. In the trend of economic globalization, the market competition is the competition combined with the talent in innovating, assimilating, sharing, transferring and implementing the new knowledge related to this industry in the world. Each firm has their own strategy to win the competition advantage. However, the developing strategy of any enterprise will be implemented by a portfolio of projects. Innovation is an inherent characteristic of project, since project is identified as a unique and one time endeavor. By innovation, project can complete on time and satisfy their customers within the budget.

Construction projects is quite different from other projects, since construction products are immobility, diversity, big size and long construction period, etc.. With the elevation of consumers’ level, construction project become more and more diversified, and much higher requirements for the project team, technology as well as management. Meanwhile, construction process is very complicated, along the procedure of purchasing raw materials, transportation, storage, on-the-site usage, transfer upon completion, and finally after service, the construction project relevant stakeholders could be include the material suppliers, equipment suppliers, subcontractors, owners, maintainers and so on. Therefore, the knowledge transfer among project stakeholders is more difficult than other projects. Each construction product is unique, so it requires the project team adapt to the innovating environment. All these lead to the fact that each construction task requires for new knowledge and techniques, thus requiring for certain innovation. Therefore, we can briefly describe the characteristics of construction project is unique product, uncertainty, ambiguity and complexity.

Although such managerial ideas and techniques as subcontracting, bidding, supervising, project management, and FIDIC contract have been introduced to China’s traditional construction industry, it only passively responds to market and still lacks its own managerial model. Especially, for some construction projects, the knowledge out of date in this field is still widely used in practice. When some creative behaviors happened, transferring the innovation to the whole project may suffer barriers from various related people. The ratio of project contract completion on time is low in China and there are some complains from project customers. Facing the impendent 2008 Olympics Games in Beijing and 2010 World Expo in Shanghai, China’s construction project weak at self-learning is the bottleneck to

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support these events successfully. Under the current situation, the gap of China’s construction project level and the modern higher requirements for construction products from consumers and mage events should be make up as soon as possible. Therefore, the knowledge innovation driven mode of construction project is put forth, in this paper, we try to pursue the driven rules and explore the motivation mechanism to encourage more innovation and promote the knowledge transfer smoothly in this field. Finally, improve the construction project contract capability in the world.

2. The Motivational Mechanism of Knowledge Innovation for Construction Project in China

2.1 Study on the Innovative Teams of Construction Project

As we know, people are the core of any innovation. For construction project, people belong to different department, such as construction material, design, construction equipment, construction information, and construction management. According to the people involved in the project, the innovative subjects of construction projects, knowledge innovation can be horizontally classified into core level, corporate level, and peripheral level, as shown in Exhibit 1.

![Fig.1 The composite of innovation subjects for construction project](image)

As shown in figure 1, every construction project includes lots of fields of knowledge, such as engineering construction knowledge, management knowledge, information technology, and so on. But the essence of project innovation is always the people in the varied project teams and fields. Therefore, the basic dynamic mechanism of knowledge innovation will fall back on to motivate each individual in the project team.

2.2 Intrinsic Drive and Extrinsic Drive: Dual Dynamic Model of Knowledge Innovation in Construction Project

To explore the motivation of knowledge innovation, we analyze where the innovation behavior starts in construction project to find a way to motivate such kind of behaviors. Gereffi’s (1994) research provided a relatively effective solution, producer-buyer dual dynamic mechanism. By our analysis, here exists a similar dual dynamic model. In other words, the original innovation is achieved through the intrinsic or extrinsic drive of project teams generally.

Intrinsic drive model is to promote the market needs through the investment by designers or constructors. The sponsors can be construction enterprises with technical advantage, or the sponsors are aiming at market expansion, or they can be local government with an intention to promote local
economic development. In this model, the fore-and-aft link among different organizations, which cover service, design, subcontracting and investment, etc., are strengthened. As shown in figure 2.

![Fig. 2 Intrinsic drive model of knowledge innovation](image)

Extrinsic drive model means buyers’ needs come first, or the complex environment calls for change first. The project team is passively search new way to satisfy the consumers. The extrinsic driven knowledge innovation is highly market and consumer oriented. As figure 3 shows. For example, such projects as resident house, industrial buildings and commercial buildings are of this kind.

![Fig. 3 Extrinsic drive model of knowledge innovation](image)

The obvious difference between the two driven models is the different knowledge operation rules. Intrinsic driven originating from industrial capital puts more emphasis on research and development of technology, continuous improvement of productive techniques, and incessant innovation of products. For intrinsic mode, the scale economy can be consolidated and hardware like infrastructures can be perfected. The extrinsic drive originates from commercial capital, and it emphasizes the construction of soft environment, for instance, marketing, expansion of distribution channels, obtaining scope economy, separating manufacturing from industrial chain, and intensifying communication, etc. The detailed differences between the two types can be seen as table 1, illustrated by concrete examples.

<table>
<thead>
<tr>
<th>Item</th>
<th>Intrinsic driven</th>
<th>Extrinsic driven</th>
<th>Moderately driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic source</td>
<td>Industrial capital</td>
<td>Business capital</td>
<td>Both</td>
</tr>
<tr>
<td>Examples of project</td>
<td>BOT project</td>
<td>House</td>
<td>Both</td>
</tr>
<tr>
<td>Countries</td>
<td>Infrastructure</td>
<td>Commercial building</td>
<td>In developing countries</td>
</tr>
<tr>
<td>Focus</td>
<td>In developing and developed countries</td>
<td>Focus on circulation</td>
<td>Between them</td>
</tr>
</tbody>
</table>

The model mentioned above is in developed countries. It starts from a dominating part of the project, which can integrate and drive knowledge dissemination. While, for most of China’s enterprises, there is no mature market mechanism and most of them is moderately driven. Through our research, China’s construction enterprises are neither fully producer-driven nor fully consumer-driven, but stay in between, which means they’ve got the characteristics of both.

The value formation of intrinsic driven or extrinsic driven is not equably or linearly distributed along the procedure from production to circulation. In the extrinsic driven chains, the marginal rate of...
knowledge value is increasing, while in the intrinsic driven chains, the majority of value increase is happened in production process and knowledge value increase upon the transformation from production to circulation. Its characteristics are shown in table 1, compared with the dual dynamic model.

2.3 Combining Motivational mechanism and Knowledge Innovation in Construction Project

Managing motivation, especially balancing intrinsic and extrinsic motivation, is an important and hard-to-imitate competitive advantage. This capability is crucial for all tasks in which the goals are difficult to formulate and where it is difficult to attribute task completion to particular employees.

Table 2 presents a typology of project forms in two dimensions of motivation and knowledge. It discusses which project forms can best enable the innovation of explicit or implicit knowledge with respect to the required extrinsic or intrinsic motivation. Here the intrinsic motivation briefly refers to individual’s desire to sustainable growth or contribution to the group he/she exists, more spiritual. On the other hand, the extrinsic motivation refers to the desire to prove individual value by more material way, such as money. The four types of project occur only rarely in pure form. For the sake of clarity, we will not consider hybrid forms of organization like strategic alliances.

Table 2. Combining Project team and Knowledge Innovation

<table>
<thead>
<tr>
<th>Knowledge Innovation and Transfer</th>
<th>Implicit</th>
<th>Explicit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivational mechanism</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrinsic</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Knowledge-based production teams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge producing teams, e.g.</td>
<td></td>
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<tr>
<td>quality circles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extrinsic</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Independent knowledge workers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit centers, holdings, brands</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cell 1 describes the situation commonly considered as running a firm “as if it were a set of markets.” Prominent examples of this advice are profit centers, pin-offs, or holdings. We can take the real estate market in 2005-2006 in China as example. This advice is well taken if the necessary knowledge to be transferred between the decentralized units is either encapsulated in a marketable product or is otherwise explicit. Market prices serve to calculate the contribution of each unit to the corporate outcome.

Cell 2 considers the case of “knowledge-based production teams.” The exchange of tacit knowledge is concentrated within an organizational unit. In addition, knowledge remains tacit and cannot be translated into action subject to commands. Examples are the design of complex construction of facilities. The tacit knowledge is embodied in the product itself, it can neither be made explicit via reverse engineering nor can it be encapsulated in an expert-system software. Such activities are the basis for a long-run competitive advantage in the form of core competencies that are difficult to imitate. To keep this advantage, these activities have to remain inside a work team and should not be dissected into profit centers or outsourced.

Cell 3 deals with those cases where parts of tacit knowledge are made explicit. The conversion of tacit into explicit knowledge at the individual level is an important part of the process of creating firm-specific tacit knowledge. During this process, individual tacit knowledge is amplified and crystallized in the form of routines. According to the resource-based view of the firm, organizational routines, embodied in the individual’s as well as in the firm’s tacit knowledge, are the most sustainable source of hard-to-imitate competitive advantages.

Cell 4 concerns independent knowledge workers in a firm. They are independent in the sense that they are not working in a team with co specialized workers with whom they share implicit knowledge. Examples are experts, like construction machine repaired expert; these workers rely strongly on their specific tacit knowledge. The application of tacit knowledge itself cannot be measured, but its output can be compensated according to its value to the organization. In contrast to Cells 2 and 3, this output can be attributed to the independent knowledge worker. In this case no intrinsic motivation is needed. But the performance of such independent knowledge workers does not contribute to a sustainable competitive advantage. Other firms can easily woo them away and profit from their tacit knowledge.
3 Conclusions

Our analysis allows us to draw four conclusions. First, Knowledge innovation is the inherent characteristic of construction project, but there are still many complex and unique problems in current China’s construction project management. Understanding the dynamic mechanism for innovation in construction project is to solve the problem from the starting point.

Second, construction project involves many subjects in different fields, in order to cooperate and motivate these people, we classify the dynamic mechanism of project innovation into three types: intrinsic driven, extrinsic driven and middle driven. Intrinsic driven originating from industrial capital, but Extrinsic originates from commercial capital, the previous two starts from a dominating part of the project, which can integrate and drive knowledge dissemination. While most of China’s enterprises, just stay in between.

Third, Intrinsic motivation is important for a project. It has great advantages in areas where prices and markets play a minor role. The decision to rely on and enable intrinsic motivation depends strongly on the need to generate and transfer implicit knowledge. This knowledge is an important source for sustaining competitive advantage of the project. Explicit knowledge, on the other hand, is tradable. Managers are more capable of observing how well workers with individual knowledge have performed in this respect, and can reward them accordingly. Markets systematically use extrinsic incentives for motivational purposes. While sometimes, instead, organizational forms that emphasize participation and personal relationship, such as linking pins or overlapping teams, are needed.

Fourth, we conclude a final suggestion for project manager: based on the dynamics of the project, project manager can manage motivation better according to the relative advantages and disadvantages of intrinsic and extrinsic motivation, or managers can choose an optimal combination to motivate the project team.

References