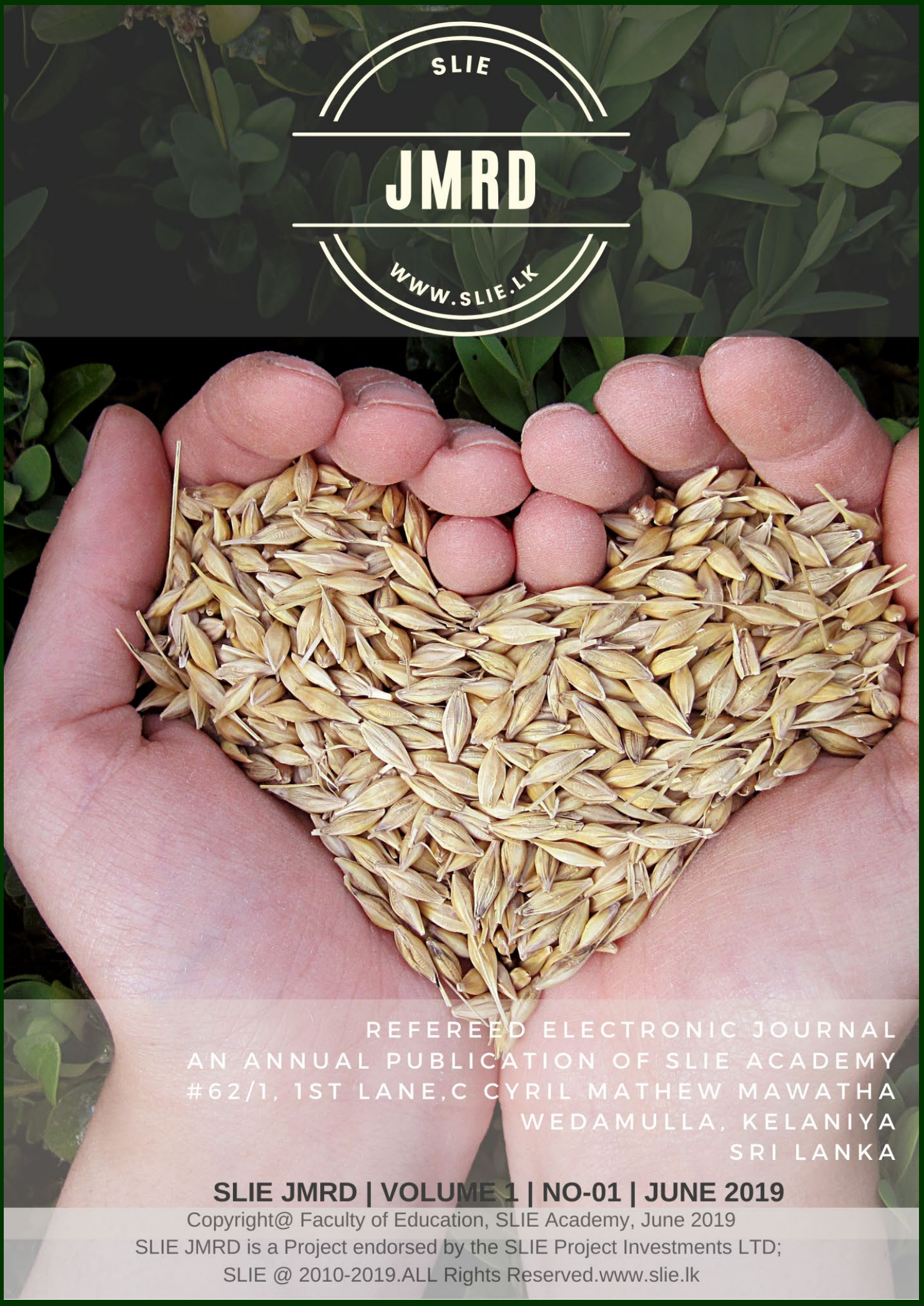

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Alternative Succession modes for the Business Succession

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Abstract

According to the research findings only 30% of Family Owned Companies (FOB) survive into the second generation and 15% survive into the third generation. Because of this background, the interest parties is searching most appropriate succession mode for the efficacious continuation of the FOB. Firstly, under this paper is conflated all the alternative modes that have to accomplish that purpose. Secondly it has given concentration to elaborate the exceptional alternative named "Joint venture". That brings unique benefits to the FOB., in one hand responds to the succession issue, because the organization is going to handle a person who has been success as an entrepreneur in the similar field and other hand carries no of supplementary benefits that cannot expect from any other alternative modes. When FOB selects international company as a joint partner, it brings more additional benefits than the domestic partner, because it is automatically opened a new market to the business.

Key Words: Business Succession, Joint venture, Incumbent, Successor

Introduction

Ownership transfer, in one form or another, is assumed to be critical to the success and continuity of the Family Owned Business (FOB). The incapability of FOB owners to successfully transfer the business to new owners may lead to a rise in business shut down rates. To ensure business survival with healthier performance, owners of FOB may need to develop succession planning in proper manner. It could therefore be argued that more owners of FOB's should address the attitudinal, resource and operational barriers to inter-generational succession within the family (or dominant kinship group).

As per the research findings, FOB has given their first propriety to handover the business to the family member, because their ambition is to defend company ownership with the family. To achieve this intention, they are transferring management and control to the next generation of family members (Morris et al 1997; Lansberg, 1999, De Alwis, 2013). The prime rationale for this intergenerational succession stems from the belief that family members are able to accumulate social capital, resources and specific knowledge on how to run the firm in a more efficient and profitable manner than would otherwise be possible (Bjuggren and Sund, 2001).

However, few FOBs seem capable of successfully transferring their businesses to the next generation either because there is no successor, no suitably qualified successor or because the commitment of the chosen successor towards their FOB is in question. According to the research outputs only 30% of family firms survive into the second generation and 15% survive into the third generation (Ward, 1987 ; Kets de Vries, 1993). In addition to that owner's reluctance to hand over the business to next during his lifetime badly affected to the business continuation (De Alwis,2016a, 2016c) Further Family members influences also badly influence to the smooth progress of the entity (De Alwis, 2016 b). As per De Alwis (2016), Incumbents related factors, owner family related factors and incumbent related factors influenced to this intergeneration succession in both positive and negative directions (De Alwis, 2016d) .Finally, It has been shown that two-thirds of family firms actually fail to plan at all for generational succession. Because of this background, there is an issue has been raised "Is generation to generation the best route for the family business succession?"

Family Owned Business (FOB)

The FOB is a predominant form of business organization, which plays a crucial role in today's economy and social well-being. It is estimated that family organizations, in various nations around the world, account for 65% to 90% of all businesses and there is great evidence that this phenomenon will grow over time (Beckhard & Dyer, 1983).

Actually, it is difficult to find consensus on the exact definition of a family business. There exists at present no standard definition for a FOB. However, main criteria suitable to include for that purpose are

a) A strong link of a family with the business through the owner by means of the capital being held by the family or the management through family members

b) Strong influence of the family with regard to strategic decisions of the company

c) The intergenerational desire to maintain the business as an asset within a small circle of owners (the family) and to guide the development of the business, including the naming of a successor

Under this background with that decision criteria's, follow definition as most suitable for the study. FOB is "a business governed and/or managed with the intention to shape and pursue the vision of the business held by a dominant coalition controlled by members of the same family or a small number of families in a manner that is potentially sustainable across generations of the family or families" (Chua and Chrisman 1999). Nevertheless, there is still no common agreement as to what the term family business actually means probably because of the difficulties associated with differentiating family from non-family organizations.

Family Business Succession

Succession is a mutual interaction that occurs between the predecessor and successor throughout the transferring process of leadership (Churchill & Hatten, 1987) and a common organizational contest to ensure the survival of incumbent forms in operation. Actually, it is not a single event; it consists by no of stages. To remain as a family business, each generation must be taken over by next, which is the ultimate managerial challenge for owners, successors, family members and other stakeholders. But intergeneration succession has become very unsuccessful for the majority of FOB's. According to the research findings only 30% of family FOBs survive into the second generation and 15% survive into the third generation. Therefore, business succession has gone beyond that stage by considering not for the family control but for the survival for the organization with favorable outcome (De Alwis, 2015). In other wards with the succession has become management succession as well as ownership succession. Therefore it is better to defined as the passing of the leadership baton from the founder-owner or incumbent-owner to a successor, who will either be a family member or a nonfamily member (De Alwis, 2012, 2015) or go for an almost new alternative such as trade sale, Management buyout, management buy in , joint venture (JV) and etc (De Alwis, 2012) .

However, most studies have exclusively focused upon succession within the family, but at the same time a number of research evidence suggest that, in some occasions, there may be no suitable family members willing or able to take on the ownership and / or the management of the FOB (Wright et al., 1992; Birley et al., 1999).

Different Alternatives for the Family Business Succession

The survival of family firms is an important entrepreneurial sustainability issue. Further, the failure to carefully consider succession issues may have a harmful impact on the long-term survival of FOB economic units and the social cohesion of local communities. Transferring ownership beyond the founder presents major challenges for FOB's where the dominant family group owns the majority of ownership in the business. The majority of family firms fail to plan for generational succession, and the process is not fully understood. Various ownership succession options are available beyond passing the business to the next generation of members drawn from the dominant family or kinship group. When a family succession is impossible but the family does not want to sell the family business, a call can be made on an outside professional manager to lead the company (professionalization of the FOB), whether temporarily or not. By this way, the family can keep the control over the family business, but it fills the gap which has developed on a managerial level. In certain cases it can be useful for the family business to call on an interim or "regency" manager. The latter assumes the management of the family business while waiting for the family successors to be fully prepared for their job.

Some researchers discuss about trade sale as alternative for the succession, but Initial Public offerings (IPO) are rarely feasible and trade sales may be unattractive to vendors if they may be associated with a loss of a firm's independent identity. Another option is the transfer of family firm ownership to internal incumbent managers through an MBO, or the transfer to external managers through an MBI.

Post-MBO/I there is a greater possibility that the firm's identity and culture will remain the same, both of which are important for family firm owners. An attractive feature of both MBOs and MBIs is that many incumbent managers may remain in place and family members can continue to be involved. Family owners may make it a condition of the deal that they retain some involvement in the firm even though they relinquish both ownership and managerial control.

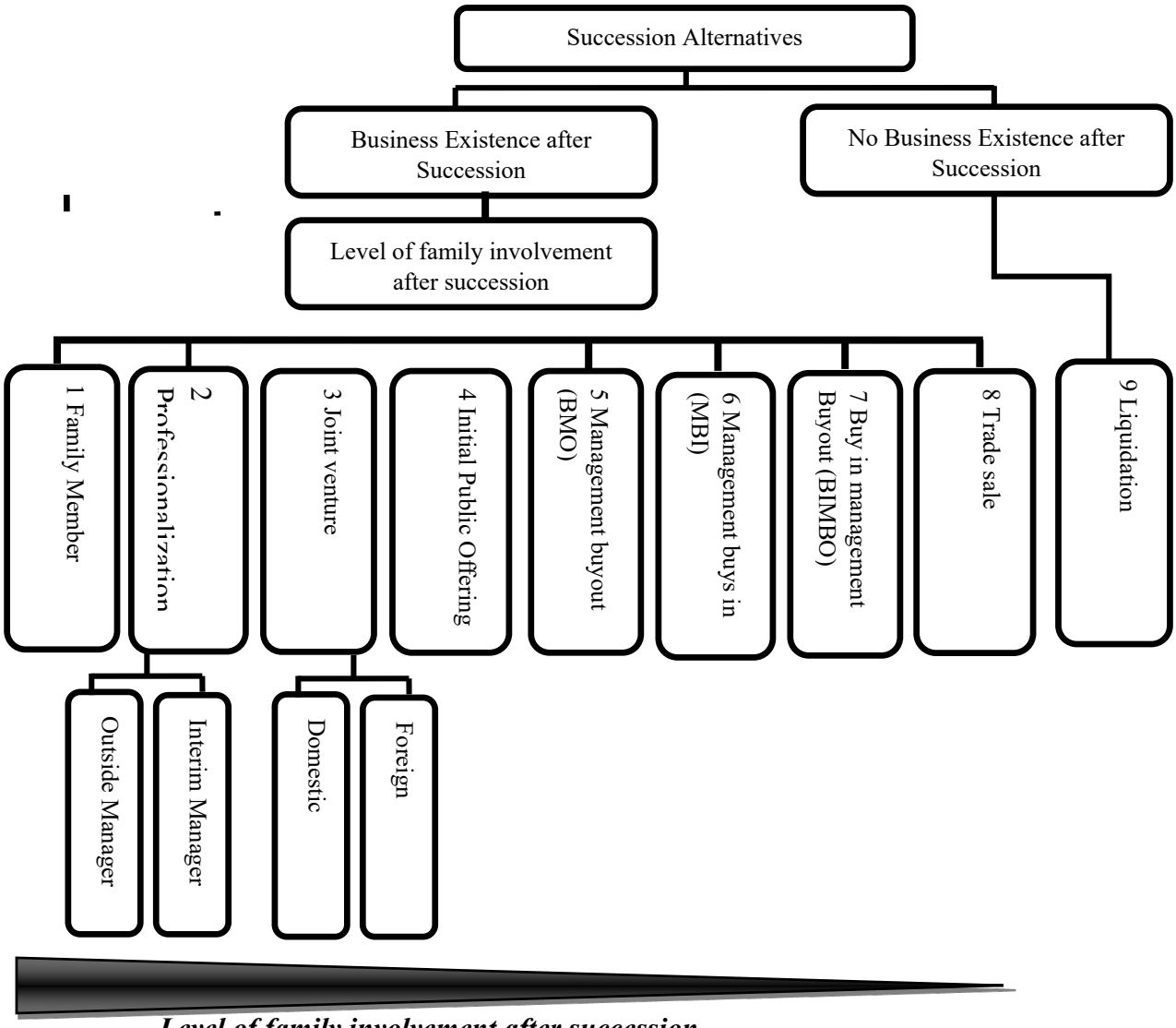
Buy in management Buyout is another choice (www.mybusiness.co.uk, 2009). This option is the combination of an MBO and MBI and involves the internal management team bringing in an external manager. This method combines the knowledge of the existing team with the extra expertise of a person from outside the company.

In addition to that there is another alternative, that is joint venture (JV) with domestic or international partner, but it did not get attention in research studies as succession mode.

Those all the alternatives that can be applied for the succession are shown in the figure no 1. At the beginning, those can be divided in to two segments as "Business existence after succession" and "No business existence after succession", because after implementing succession some succession mode (liquidation), there is no company existence hereafter. Again that "Business existence after succession" can be categorized again in descending order as "Family involvement after succession".

The most famous succession mode is succession with family member. It represents the highest family involvement and trade sale has the lowest family involvement after succession. Professionalization of the management is in the second and Joint venture is in the third place under this category. Four of other alternatives initial public officering, Management buyout (MBO), Management buy in (MBI) and But in Management buyout (BIMBO) can be can be put in a row respectively from highest involvement to lowest involvement of family.

Figure no I : Alternatives for Family Business Succession



Source: De Alwis A.C (2012), Family Business Succession in Medium Suze Family Companies, Doctoral Thesis, Tomas Bata University in Zlin

Joint Venture

The term 'joint venture' (JV) is an umbrella term which describes the commercial arrangement between two or more economically independent entities. In practice, the legal form of a joint venture is likely to be determined by a number of factors including the nature and size of enterprise, the anticipated length of the venture, the identity and location of the ventures and the commercial and financial objectives of the participants.

Three basic legal structures can be used for joint venture, as a limited liability company (i.e. a corporate vehicle), a partnership or limited partnership (i.e. an unincorporated vehicle) and a purely contractual co-operation agreement. Again it can be divide whether partner organization's background, whether it is national (domestic) or international entity.

Reasons for Forming a Joint Venture- There are many motivations that lead to the formation of a JV. They include:

- Risk Sharing – Risk sharing is a common reason to form a JV, particularly, in highly capital intensive industries and in industries where the high costs of product development equal a high likelihood of failure of any particular product.
- Economies of Scale – If an industry has high fixed costs, a JV with a larger company can provide the economies of scale necessary to compete globally and can be an effective way by which two companies can pool resources and achieve critical mass.
- Market Access – For companies that lack a basic understanding of customers and the relationship/infrastructure to distribute their products to customers, forming a JV with the right partner can provide instant access to established, efficient and effective distribution channels and receptive customer bases. This is important to a company because creating new distribution channels and identifying new customer bases can be extremely difficult, time consuming and expensive activities.
- Geographical Constraints – When there is an attractive business opportunity in a foreign market, partnering with a local company is attractive to a foreign company because penetrating a foreign market can be difficult both because of a lack of experience in such market and local barriers to foreign-owned or foreign-controlled companies.
- Funding Constraints – When a company is confronted with high up-front development costs, finding the right JVP can provide necessary financing and credibility with third parties.

  No satiable successor within the company – When there is no competence successor within the FOB, they are going to give attention to other alternatives. If they want to maintain controlling power with the company, they have two alternatives as appointing a manager or going to joint venture.

  Acquisition Barriers; Prelude to Acquisition – When a company wants to acquire another but cannot due to cost, size, or geographical restrictions or legal barriers, teaming up with a JVP is an attractive option. The JV is substantially less costly and thus less risky than complete acquisitions, and is sometimes used as a first step to a complete acquisition with the JVP. Such an arrangement allows the purchaser the flexibility to cut its losses if the investment proves less fruitful than anticipated or to acquire the remainder of the company under certain circumstances

International Joint venture as s solution for succession problem

If the FOB does not have competent single to take the batten form the incumbent and the same time company owners do not happy to drop the controlling power of the company, they have to consider another alternatives that is closed to the 1st alternative shown in the figure no1. Most suitable one is appointing non-family manager (professionalization) for the position. That is second alternative of the figure no1. Third option is going for a joint venture (JV).

Actually it brings solution for the succession problem as well as its help to enhance the strength of the company. Company is now more powerful than the earlier, person who have experienced in the same field has taken the batten, and it is helpful for the smooth continuation.

Under this JV brings not only the solution for the succession problem but also it is strengthen the organization against globalized, drastically changing international environment because it helps to increased competitive intensity of the company.

The obvious benefit that exists with partnering is that economies of scale play a key role in adding additional earnings to both businesses. If the two entities can establish a well thought out plan of integration and profit sharing, the “financial lift” from this combination can create enough additional free cash flow to fund a buy-sell agreement that could be included in the partnership agreement.

Conversely, partnerships or joint ventures are flexible enough that an incumbent easily can relax his business in the event that things do not work out between the two parties. Essentially, it creates the best of both worlds in that it allows for enough flexibility to the owner to create his own succession plan, while also satisfying the need gradually to obtain liquidity from the business.

In addition, key family members within the FOB are given an opportunity to remain with the operation and potentially can be awarded ownership in the combined entity upon formalization of a sale option that can be included in the partnership agreement. This allows for continuation of the family’s legacy through participation in a larger company, while gradually merging it into another entity.

Conversely, the joint venture partner may find this to be the best of both worlds as well. They are able to execute effectively an acquisition strategy but to perform it on a more gradual basis. This minimizes their risk and allows time for both parties to integrate successfully the agencies into a more efficient operating model.

The key to remember in developing such a strategy is that there must be a clearly thought out plan on the front end of discussions. There must be openness to modifying both operations to achieve the desired financial optimization.

There are no of additional benefits can be identified with alternative. First, the firm can achieve greater operational efficiencies. Secondly, it can reduce the risks (commercial or political) associated with international business, because it's automatically open new market for the company. Thirdly, it's bringing synergy to the organization. Fourthly it can exploit national and/or differential advantages of partners. Fifth one is sharing some value-adding activities with a foreign firm; it can free scarce capital for use where it has competitive advantage. Sixth one is, it can gain speed in getting products to market. Seventh, it can establish long-term relationships with a global network of suppliers, distributors, and other intermediaries.

But this everything is depending on the ideal selection of foreign partner. If company select incorrect, unsuitable, inappropriate one, it will speed up the process of shut downing the organization, because it can become additional burden to the whole system, therefore incumbent need to articulate the profile of an ideal foreign business partners.

Specific selection criteria and relative weights may be developed and used in evaluating candidates. In general, incumbent will be looking for a good fit in terms of both strategy (common goals and objectives regarding business and future growth) and resources (complementarities in core competencies and value-chain activities). It is important for incumbent to try to anticipate the degree of synergy with the potential partner. In other words, managers must be assured of a harmonious relationship with the partner in a dynamic environment.

Assuming that FOB has already qualified and selected a suitable partner, it is critical to have a good understanding of the partner's organization and leadership. What are the advantages for the partner? What are the primary motivations of senior decision makers in this relationship? How will they benefit? How can we help them succeed? In other words, the incumbent must develop a sound understanding of what the partner wants from this venture and how to help achieve those objectives.

It is best for incumbent to establish explicit criteria by which they can evaluate the success of the venture and its contribution to the firm's goals. These criteria, which are likely to be derived from the underlying rationale for the venture, encompass strategic, operational, and "learning" objectives within specific time intervals.

In addition that , incumbent need to institute proper procedures for monitoring the outcomes of the collaborative venture as well as control mechanisms for taking corrective action when required. Management will want to watch closely the accomplishment of specific objectives determined at the outset for the partnership - such as cash flow, shareholder value, brand equity, and cost reduction. Ideally, information feedback should be complete and rapid, leading to appropriate management actions. It is also important to assign clear roles and responsibilities to individuals who will be charged with managing the relationship.

Beyond establishing performance benchmarks and monitoring them, both organizations should formulate a vision for the future of the collaborative venture. Should the relationship be expanded as is or take on new facets? Is the partner able and willing to grow the venture? What proactive steps can be taken today that will bear fruit tomorrow? Is the venture able to capitalize on new opportunities as they arise? This sort of deliberation is essential if a relationship is to grow and strengthen.

Conclusion

Business succession is the fundamental issue faced by the FOB in all over the world. Actually it is problem that has to resolve within the company, The owner and other stakeholders should find a most appropriate solution for it. If they failed to do it, first it damages to the smooth continuation of the company. Secondly it affects to the national economy in diverse angels such as Demotic National Production (GDP), Unemployment rate and etc. Under this critical background, researchers, thinkers and consultants who interest in this entity, suggests no of alternatives to practice as succession mode. Herewith this article is going to add new way of succession mode. That is international joint venture. Actually it is not a just alternative, but also it brings number of competitive advantages too.

The company is going to the hands that have more experience in the same business filed with the international exposure. That will help to run business more smoothly sometime better then the before succession because after the succession, it opens new market to the business and brings a opportunity to get international exposure to the 2nd generation.

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References

1. Beckhard R, Dyer W. (1983). Managing Change in the Family Firms - Issues and strategies. Sloan Management Review 24: 59- 65
2. Bjuggren, P., & Sund, L. (2001). Strategic decision making in intergenerational successions of
3. Chua, J.H., Chrisman, J.J., & Sharma, P. (1999). Defining the family business by behavior. Entrepreneurship Theory & Practice, 23(4), 19-40.
4. Churchill, N. C., & Hatten, K. J. (1987, Fall). Non-market-based transfer of wealth and power: A research framework for family businesses. American Journal of Small Business, 12, 53–66.

5. De Alwis A.C (2012), Family Business Succession in Medium Size Family Companies , Doctoral Thesis, Tomas Bata University in Zlin
6. DE ALWIS A.C (2013) Successor's satisfaction on business succession process, *MANažment a EKOnomika, MANažment a EKOnomika*, MANEKO:, p.15 -28, ISSN: 1337-9488
7. De Alwis A.C. (2015) Post Succession Performance in Medium Size Family Companies, Kelaniya Journal of Management, Vol. 3, Iss. 2
8. De Alwis A.C. (2016a), Incumbents Influence On Family Business Succession Process, European Journal of Business and Management. Vol.8, No.13, 2016
9. De Alwis A.C. (2016b), Owner family and business succession in family owned companies, Acta Oeconomic a Universit atis Selye Vedecký recenzovaný časopis 5. ročník 1. Číslo,
10. De Alwis A.C., (2016c), Incumbents Influence On Family Business Succession Process, European Journal of Business and Management. Vol.8, No.13, 2016
11. De Alwis, A. C. (2016d) Stakeholders Influence on Successful Business Succession. International Journal of Business Administration, 7(4).
12. Lansberg, I. (1999). Succeeding generations: Realizing the dreams of families in business. Boston: Harvard Business School Press.
13. Master, I, & Lievens, j., (2010) , The Succession scorecard, a tool to assist family business's trans-generational continuity. Retrieved from http://www.ownershiptransfer2010.org/wp-content/uploads/2010/03/
14. Morris, M. H., Williams, R. O., Allen, J. A., & Avila, R. A. (1997). Correlates of success in family business transitions. Journal of Business Venturing, 12, 385-401.
15. Plan for succession in a family business. (2009). (Web). Retrieved from http://www.mybusiness.co.uk/Yc7iodBofDymQQ.html
    a. small- and medium-sized family-owned businesses. *Family Business Review,* 14, 11-24.
16. Ward J.L., (1987), Keeping in Family Business Helthy: how to plan continues growth,Profirability and family leadership. San Francisco, Jossey Bass

Does size of construction firms matter? Impact of project-related and organizational-related factors on project performance

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Introduction

The construction industry is one of the critical backbones of economic transformation in any country. Universally, the performance of construction industry is vital and crucial for a country's economic activities. Several studies have been conducted in the last four decades in different parts of the world to understand the factors that lead to success of projects in the construction industry. According to Bronte (2015) and Sambasivan et al. (2017), despite several studies, construction projects around the world suffer from issues like time overruns, cost overruns, quality problems, contract management disputes, scope changes, design changes, client interference, stop-works, project abandonment, subcontractor problems, labor shortage, financial problems, design failures, material problems and so on. Sambasivan et al. (2017) have stated that 70% of the construction projects experience 10–30% of time overrun against their original schedules and the cost overrun in the projects is approximately 20% of the original budgeted cost. The time and cost overruns are compounded by quality and safety-related problems leading to project failures and financial losses. Belassi, Kondra, and Tukel (2007) have stated that 75% of business transformation projects fail to achieve their objectives. A pertinent question that has been answered partially by the literature is: Does size of the construction firms matter in assessing the factors that lead to better performance? The researchers have typically looked at size of the construction firm from three perspectives: (1) using as a control variable (Sekar, Viswanathan, and Sambasivan, 2018), (2) studying large firms to understand the complexities (Guo, Li and Li, 2013; Park and Papadopoulou, 2012), and (3) studying SMEs to understand the project management processes (Sadaba et al., 2014; Turner, Ledwith and Kelly, 2010).

This research fills the gap in the literature by specifically analyzing the impact of (success) factors on five dimensions of project performance for small and medium sized (SMEs) and large construction firms in the context of Malaysia. The construction sector contributes significantly to the GDP of Malaysia (4.89%) and the overall value of the industry in 2016 was US $ 14.81 billion (Department of Statistics, Malaysia).

Before further deliberation, three critical terms that are used in this research need explanation. (1) Project-related factors are the (hard) factors that have a direct impact on the day-to-day functioning and successful completion of the project (Sambasivan & Soon, 2007). The factors considered are: client-related, contractor-related, consultant-related, material-related, labor and equipment-related, contract management-related, external-related, and use of project management tools and techniques. (2) Organizational-related factors are the (soft) factors that are management-related and play a crucial supportive role in ensuring successful completion of projects (Arditi, Nayak, & Damci, 2017; Nixon, Harrington & Parker, 2012). The factors considered are: leadership, organizational culture, innovation, and learning organization. (3) Project performance consists of five dimensions: time, cost, quality, safety, and financial (Sambasivan & Soon, 2007; Tabish & Jha, 2015). What is the difference between cost performance and financial performance? Cost performance deals with: completing the project within the budgeted cost (includes direct and indirect costs), raising cost claims to the client promptly, timely certification of cost claims by the client, managing costs related to change orders in the project, and settling of cost-related disputes with the clients. Financial performance deals with: earning profits from the project, achieving ROI (if applicable), ROA (if applicable) and ROE (if applicable) from the project, and the project's contribution to organization's overall financial performance.

Why is the study of firm size in the construction industry important? Many researchers have highlighted the importance of firm size on success factors and performance.

For example, Welling and Kamann (2001) have argued that size of the construction firms do matter for vertical cooperation (with suppliers and sub-contractors); Pagano (2003) have studied the link between firm size and economic growth; Fabiano, Curro and Pastorino (2004) have studied the positive link between the firm size and safety performance of construction firms; Leung, Meh and Tarajima (2008) have highlighted a positive relationship between firm size and productivity of construction firms; Lee (2009) has shown the relationship between firm size and financial performance of public firms in US; Zeng and Luo (2012) have highlighted the link between firm size and organizational culture; Roxas, Battisti and Deakins (2014) have argued that innovation and learning capabilities of firms depend upon their size; Lejarraga and Martinez-Ros (2014) have established the relationship between firm size and organizational-decision making processes and innovation; Vargas (2015) has linked the role of firm size to identify barriers to economic performance.

Based on the earlier studies, it is obvious that firm size does have an impact on many factors and performance indicators. However, most of the studies have been conducted in firms in different types of industry and there are only a few studies that have studied the impact of firm size in the construction industry (For example, Fabiano et al., 2004; Leung et al., 2008). Therefore, it is important in the construction industry to understand the effect of firm size especially, while assessing factors and performance indicators that can be impacted by it. This research contributes in two ways. First, a comprehensive framework that includes project-related and organizational-related factors and five dimensions of project performance have been studied.

Analyzing the impact of factors on the performance of SME and large construction firms can significantly enhance the body of knowledge about construction industry. A recent study by Sekar et al. (2018) has used firm size as a control variable and has shown its effect on different sectors in the construction industry. Second, the findings of this study can help the project managers to devise the right strategies to manage projects executed by SME and large construction firms in a more effective manner.

Literature review

Project-related factors

In the last three decades, many papers from different countries have been published establishing the links between project-related factors (client-related, contractor-related, consultant-related, material-related, labor and equipment-related, contract management-related, external-related, and use of project management tools and techniques) and performance indicators such as time, cost, and quality. For example, Sambasivan and Soon (2007) have tested the relationship between project-related factors and cost and time performance indicators in Malaysia; Swies et al. (2008) have studied the impact on time performance in Jordan; Kaliba et al. (2009) have argued the link with time and cost performance in Zambia; Yang et al. (2010) have established the relationship with time performance in Taiwan; Alinaitwe et al. (2013) have studied the relationship with cost and time performance in Uganda; Sambasivan et al. (2017) have established the link with time and cost performance in Tanzania; and Sekar et al. (2018) have tested the relationship with cost, time, safety, quality and financial performances in Malaysia. It is to be noted that not all researchers have studied the impact of all project-related factors simultaneously. There is a dearth of studies in the construction industry that have considered the impact of firm size. A recent study by Sekar et al. (2018) have analyzed the relationship between the project-related factors and five dimensions of project performance in different construction sectors such as civil, infrastructure and building, oil and gas, marine, and multi-discipline. They have used firm size as a control variable. In fact, it is this study that motivated us to ask the fundamental question: Does size of construction firms matter?

Organizational-related factors

Pollack (2007) has made an interesting observation about the project management studies in the construction industry. He has stated that the studies are largely based on project-related factors. In the last decade, there have been research papers based on organizational-related factors. To recap, organizational-related factors considered in this research are: leadership, organizational culture, organizational learning, and innovation.

According to Muller and Turner (2007), previous studies on project performance have largely ignored the leadership roles of project managers and their leadership styles. Leadership style that brings together agility and trust among the team members leads to greater project performance (Anantamula, 2010; Oliveria, Veriano & Possamai, 2012). According to Muller and Turner (2007), "different leadership styles are more likely to lead to a successful outcome on different types of project." (p. 21). Nixon et al. (2012) have indicated that there is no single leadership style that is suitable for the entire life cycle of a project. They have argued that leadership styles and models should be modified to suit the project performance outcomes and requirements based on each situation. Sekar et al. (2018) have shown that leadership has impact in marine, oil and gas and multi-discipline sectors of construction industry.

A few researchers have established the strong influence of organizational culture on project performance (Belout & Gauvreau, 2004; Belassi et al., 2007; Vaidyanathan, 2016; Yazici, 2009). For example, Belassi et al. (2007) have demonstrated the influence of organizational culture on new product development projects; Yazici (2009) has studied the impact of different culture types on perceived performance of projects; Vaidyanathan (2016) has studied the effectiveness of culture on IT projects; Nguyen and Watanabe (2017) have analyzed the significant effect of culture on the performance of construction projects in Vietnam. According to Sekar et al. (2018), organizational culture has impact in all the sectors of the construction industry.

The role of innovation in the management of projects has been known for more than five decades (Davies, 2014). However, the study of impact of innovation on construction projects started much later. In fact, Dubios and Gadde (2002) have stated that the nature of working and decision-making styles and government regulations hamper the innovation in the construction industry. However, some scholars like Egbu (2004), Gambatese and Hallowell (2011) and Walker (2016) have argued for the significant role of innovation and factors favoring innovation in the construction industry.

For example, Gambatese and Hollowell (2011) have stated that “innovation is vital to successful, long-term company performance in the construction industry” (p. 553); Walker (2016) highlights the significance of innovation and suggests that the blend of data, information, and knowledge using ‘Big Data’ analytics can foster innovation in the construction industry. Sekar et al. (2018) have shown that innovation has impact in marine and oil and gas sectors of construction industry.

According to Senge (1990), learning organization is defined as an “organization with an ingrained philosophy for anticipating, reacting and responding to change, complexity and uncertainty." (p. 3). Among the various researchers that have highlighted the importance of learning organization in the construction industry, Chinowsky, Molenaar, and Realph (2007) have provided the most appropriate and apt explanation. They have stated that “for the construction industry to adopt a learning organization culture the concept of continuous learning and personal advancement must become a fundamental operating concept within organizations at every level and throughout every project and business process.” (p. 33). Similar thoughts on the construction industry have been echoed by Love, Huang, Edwards, and Irani (2004), Chan, Cooper, and Tzortzopoulos (2005), and Tennant and Fernie (2013). According to Sekar et al. (2018), organizational culture has impact in all the sectors of the construction industry.

Firm size

There are a very few studies that have studied the impact of firm size in the construction industry. McVittle, Bainikin, and Brocklebank (1997) have studied the effects of firm size on injury in construction industry in Canada. They have also shown that injuries increase as firm size decrease. Welling and Kamann (2001) have used game theory to explain the process of vertical cooperation with suppliers and contractors. They have argued that cooperation is more in small firms than large firms. Fabiano et al. (2004) have analyzed the impact of firm size on accident-related injuries in the Italian industry.

They have found that fatality of accidents in construction industry increases with decrease in firm size. Leung et al. (2008) have compared the productivity of firms in different industries in US and Canada. Among the various industries, Leung et al. have highlighted the existence of a positive relationship between firm size and productivity of construction firms. Anikeef and Sriram (2008) have analyzed the relationship between firm size, construction management strategy and performance. They have shown that firm size does have impact on strategy and performance. Kim and Reinschmidt (2012) have studied the construction industry in USA and have concluded that firm size does not have impact on growth performance. Yoo and Kim (2015) have reported that the firm size and profitability are negatively correlated in the Korean construction industry. Sekar et al. (2018) have shown that firm size, as control variable, impacts all the sectors in the construction industry in Malaysia. Based on the review of literature, it is obvious that the impact of firm size in the construction industry has not been given the due importance it deserves. Most of the studies concentrated on the link between firm size and performance. The current research fills the gap by specifically comparing the impacts of project-related and organizational-related factors on performance for SME and large construction firms.

Indicators of project performance

Five indicators of performance considered in this study are: time, cost, safety, quality, and financial. Past studies have mainly focused on project performance indicators, such as time performance, cost performance and safety performance (Mosly, 2015; Sambasivan & Soon, 2007; Sambasivan et al., 2017). A few studies have studied the quality performance in the construction industry (Cheung, Sue, & Cheung 2004; Jha & Iyer, 2006). Sekar et al. (2018) have considered all the five indicators in their study. In general, there is a dearth of studies related to simultaneous evaluation of all the five indicators in the construction industry. Simultaneous evaluation can help the academicians and practitioners understand the relative impact of different indicators.

Hypotheses development

The integrated framework used in this research has two constructs project-related (client-related, contractor-related, consultant-related, material-related, labor and equipment-related, contract management-related, external-related, and project management tools-related) and organizational-related (leadership, organizational culture, innovation, and learning organization) factors as independent variables and five dimensions (time, cost, quality, safety, and financial) of project performance as dependent variables. The framework is given in Figure 1.

Insert Figure 1 here

Impact of project-related factors on performance

Scores of studies have tested the relationship between project-related factors and performance dimensions such as time, cost, and quality in the construction industry (For example, Alinaitwe et al., 2013; Sambasivan & Soon, 2007). Construction projects constitute a large number of activities and transactions at various stages of their life cycle with different stakeholders. Poor transaction governance is likely to increase the transaction costs in a project (Sambasivan et al., 2017). Project-related factors refer to different types of transactions in a project that are likely to impact project performance.

Scholars have used the Transaction Cost Economics (TCE) Theory and Game Theory (GT) to understand the relationships between different stakeholders in the construction industry (Lua, Zhang & Pan, 2014)). A recent study by Sambasivan et al. (2017) has established a strong link between project-related factors and performance using TCE. A study by Sekar et al. (2018) has tested the empirical relationship between project-related factors and five dimensions of performance in different sectors of the construction industry and has found significant relationships. Do the transaction costs vary according to the size of the firm? A seminal work by Nooteboom (1993) has argued that the transaction costs are higher for smaller firms. For example, smaller firms may not have the necessary administrative capacity to monitor transaction partners and evaluate alternate sources of supply and these can lead to higher transaction costs. Based on these evidences, we posit the following hypothesis:

> *H1: Project-related factors significantly impact project performance in the construction industry; the impact is more for SME construction firms than large construction firms.*

Impact of organizational-related factors on performance

Construction firms need: (1) effective leadership at the top to ensure projects are running smoothly (Oliveria et al., 2012), (2) effective organizational culture to ensure that the project teams of various projects are performing to the expected levels (Saunila, 2014), (3) innovative ways to execute projects to save cost and time without compromising on safety and quality (Saunila, 2014), and (4) to learn from their experiences with ongoing, failed, and completed projects and through other means to establish a learning organizational culture to sustain and grow business (Hardness, Nilsson & Urban, 2005; Sekar et al., 2018).

Few authors have argued about the significance of leadership in project management. Muller and Turner (2007) have stated that the project manager's leadership style does influence project success. Anantamula (2010) and Oliveria et al. (2012) have stated that leadership significantly contributes to achieving the highest project performance. Nixon et al. (2012) have outlined the importance of leadership with a caveat that leadership style may be required to be different for different stages in the life cycle of the project. For example, transformational style that brings in change may be preferred during the conceptualization and planning stages; transactional style that brings in efficiency and effectiveness may be preferred during the execution stage. Sekar et al. (2018) have shown the impact of leadership in oil and gas, marine, and multi-discipline sectors of the construction industry. Marx (2017) has studied the effect of firm size on leadership and has concluded that size does have impact on the types of leadership skills, traits, styles and effectiveness. Marx has highlighted that "leaders at larger organizations perform the functions essential to these organizations as effectively as leaders at smaller organizations perform the functions essential to their organizations" (p. 86).

The role of organizational culture in managing projects has been highlighted by academicians and practitioners for more than three decades. Few researchers have empirically tested the relationship between culture and project performance (Belassi et al., 2007; Vaidyanathan, 2016; Yazici, 2009). Sekar et al. (2018) have shown that organizational culture has impact in all sectors of construction industry.

Regarding the impact of firm size on culture, Zeng and Luo (2013) has made two interesting observations based on Denison's model (Denison & Mishra, 1995). According to that model, four culture elements are: (1) involvement, (2) adaptability, (3) consistency, and (4) mission. Zeng and Luo initially hypothesized that: (1) consistency and mission elements of organizational culture are more significant for large firms than for small firms and (2) involvement and adaptability elements are more significant for small firms than for large firms. However, the empirical study has shown that four cultural elements are significant for large firms than for small firms.

The innovation in the construction industry is critical for its survival and growth (Egbu, 2004). An initial study by Dubois & Gadde (2002) has argued that the processes and systems in the construction industry hamper innovation. However, the researchers of recent times have found a positive relationship between innovation on project performance (Walker, 2016). Xue et al., (2014) have highlighted the significance of innovation in the construction industry and have identified four critical factors (collaboration, culture, innovation process, and drivers) that enable innovation. Sekar et al. (2018) have found that innovation has impact in marine and oil and gas sectors of construction industry. While analyzing the role of firm size on innovation, many researchers have argued the relationship from different perspectives. For example, (1) Kleinknecht (1989) has observed that large firms are more innovative than SMEs because of their accessibility to capital, skills, and information; (2) Arias-Aranda, Minguela-Rata, and Rdriguez Duarte (2001) have studied engineering firms in Spain and have shown that firm size and degree of innovation are positively linked; (3) Plehn-Dujowich (2009) has highlighted that small firms are more (product) innovative than large firms as they obtain more patent counts and citations per dollar of R&D; and (4) Alsharkas (2014) after studying 1053 enterprises from 26 countries have concluded that there is a positive relationship between firm size and innovation performance. In general, the researchers subscribe to the view that firm size and degree of innovation are positively correlated.

Learning and improving continuously are vital to achieve project success (Cooke-Davis, 2002). The learning organization helps the project team to learn from the earlier experiences obtained from different projects and implement the knowledge gained in future projects (Brady & Davies, 2004). Chinowsky et al. (2007) has stated that the construction industry must adopt a learning culture across all levels in an organization and throughout every project and business processes. This capability is critical to the final performance of the projects (Tennant & Fernie, 2013). Sekar et al. (2018) have empirically shown that learning organization has a positive impact across all sectors in the construction industry.

While addressing the impact of firm size on learning organization, (1) Cho (2007) has found that there is a positive relationship between firm size and learning orientation of the organization; (2) Beyene, Shi, and Wu (2016) have shown that larger firms have better learning capability than smaller firms; and (3) Alashwal, Abdul-Rahman, and Asef (2017) have highlighted that large companies have greater ability to learn and manage risk in a matured manner when compared to smaller firms. Based on these evidences, we posit the following hypothesis:

> *H2: Organizational-related factors significantly impact project performance in the construction industry; the impact is more for large construction firms than SME construction firms.*

Methodology

This study has used a quantitative research approach to compare the impact of project-related and organizational-related factors on project performance (cost, time, safety, quality, and financial) between SMEs and large firms. A survey research design method was used to collect the data from the targeted population.

Population and sample

Construction Industry Development Board (CIDB), which is a government organization, represents the construction industry in Malaysia. The construction companies in Malaysia must register with CIDB as a contractor depending upon their capabilities from grades G1 to G7.

The G7 is the highest grade of construction companies that are eligible to carry out projects with individual project value of more than RM 10 million (USD 1 = RM 4.03). The companies falling in this category are SMEs (small & medium), and large companies. The population for this study is the active G7 construction companies which currently stand at 5134. The list published by CIDB was used as the sampling frame. About 40% of the firms fell in the SME category and the remaining in the large category which is a typical characteristic of G7 firms. Stratified random sampling procedure was adopted.

The sample size calculator (http://www.raosoft.com/samplesize.html) suggested a sample size of 358. Considering the response rate, questionnaires were sent to 1070 (approximately, 358*3) G7 companies. One of the authors works in a senior position in a G7 company and it was not difficult to get the sampling frame. Six hundred and forty (60%) questionnaires were sent to large firms and 430 (40%) were sent to SMEs.

Measures

The measures used in this study were taken from established sources as indicated in Table 1. The questionnaire consisted of five sections: Section 1 – demographic factors about the respondent (11 items); Section 2 – Organization details (10 items); Section 3 – project-related factors (35 items); Section 4 – Organizational-related factors (73 items); and Section 5 – Project performance (24 items). The items in all the constructs were measured using a 5-point Likert scale. The meaning of high scores for each factor is given in Table 2.

Insert Table 1 here

Insert Table 2 here

Pilot study

A pilot study was conducted with (1) 30 experts from the construction industry and academic faculty members to check the face validity of the questionnaire and (2) 30 project managers from the construction industry to ensure that the questionnaire and the items are relevant for the study. The experts and the project managers were in agreement with the questionnaire items and therefore, no changes were made. The questionnaires were distributed to 1070 companies.

Reliability and validity

Cronbach Alpha scores were used to assess the reliability of the dimensions (variables) of different constructs. The convergent and discriminant validities of variables were assessed using the composite reliability (CR) and average variance extracted (AVE). The reliability and validity values are given in Table 2. According to Hair et al. (2014), there are three conditions for the reliability and validity of each variable: (1) Cronbach alpha and CR scores must be above 0.7, (2) AVE values are expected to be above 0.50, and (3) AVE scores for each variable must be more than the squared correlations of that variable with other variables. The AVE scores of organizational-related variables (factors) are less than 0.5 but greater than the squared correlations as shown in Table 3. Therefore, there are no issues related to the reliability and validity of the factors.

Insert Table 3 here

Results

Descriptive statistics and correlation

We received the filled questionnaires from 360 respondents (out of 1070 questionnaires). Three hundred and forty two questionnaires (response rate = 32%) were available for further analysis after dropping the questionnaires that had significant missing information. The questionnaires were filled by project directors/managers.

Earlier studies had predominantly obtained responses from other stakeholders such as clients, contractors and consultants. About 52% of the respondents had more than 11 years of experience as project managers/directors in the construction industry. About 64% of the respondents had handled more than six projects to successful completion. About 32% (108 responses) of the respondents were from SMEs and 68% (234 responses) were from large companies. Descriptive statistics of various constructs (mean, standard deviation, skewness, and kurtosis statistics) are given in Table 4. The correlation between the various constructs is given in Table 3.

Relative importance index (RII) analysis was carried out separately for SMEs and large firms. RII is a statistical method to calculate and determine the relative importance of the variables, whose values range from zero to one. Higher values of RII for a variable indicate higher importance for that variable relative to other variables (Sambasivan & Soon 2007). RII scores for SMEs and large firms were calculated separately for project-related, organizational-related, and performance factors. The results are given in Tables 5 and 6.

Insert Table 4 here

Insert Table 5 here

Insert Table 6 here

Hypothesis testing

Hierarchical regression was used to test the hypotheses with project-related factors (block 1) and organizational-related factors (block 2) as independent variables and five dimensions of project performance as dependent variables. The regression models were run separately for SMEs and large firms. Before running the regression models, collinearity diagnostics were performed. The variance inflation factor (VIF) varied between 1.3 and 2.4 (must be less than 5) indicating that multi-collinearity effect was not a concern. The regression results indicate that in general, project-related and organizational-related factors have significant impact on project performance in the construction industry. Specifically, significant factors are different for SMEs and large firms and for each dimension of performance. The salient results are as follows.

SME construction firms (Table 7) – (1) time-related performance – organizational culture factors is significant, (2) cost-related performance – use of appropriate project management tools/techniques and organizational culture factors are significant, (3) quality-related performance – external and organizational culture factors are significant, (4) safety-related performance – consultant-related factor is significant, and (5) financial performance – organization culture and learning organization factors are significant. In order to assess the relative impact of project-related and organizational-related factors on different dimensions of performance, the proportion of adjusted R^2 values has been used. Based on the values, significant impact (more than 50%) come from organizational-related factors on all dimensions of performance except, safety-related performance.

Insert Table 7 here

Large construction firms (Table 8) -- (1) time-related performance – contractor-related, use of appropriate project management tools/techniques, organizational culture and learning organization factors are significant, (2) cost-related performance – labor and equipment-related, organizational culture and learning organization factors are significant, (3) quality-related performance – use of appropriate project management tools/techniques, organizational culture, and learning organization factors are significant, (4) safety-related performance – use of appropriate project management tools/techniques, organizational culture, innovation, and learning organization factors are significant, and (5) financial performance – contractor-related and learning organization factors are significant. Based on the contribution of adjusted R^2 values, significant contributions (more than 50%) come from organizational-related factors on all dimensions of performance.

Insert Table 8 here

Discussion

The basic objective of this research was to compare the impacts of project-related and organizational-related factors on five different dimensions of project performance among SMEs and large construction firms in Malaysia. This objective coupled with the occupation of the respondents (project managers/directors) has made this study unique. The findings of this study, therefore, add significantly to the body of knowledge related to the construction industry.

Before analyzing the findings separately for SMEs and large firms, it is useful to understand the overall impact of project-related and organizational-related factors. First, in this study, organizational-related factors have more significant impact on performance when compared to project-related factors (Sekar et al., 2018). As stated earlier, more than 70% of the projects worldwide experience several problems. We contend that in order to reduce the incidences of project failure, it is essential for the construction sector to concentrate on organizational-related factors in addition to project-related factors (Chinowsky et al., 2007; Oliveria et al., 2012; Yazici, 2009). Second, the significant project-related and organizational-related factors are different for SMEs and large firms. Third, the degree of relative impact of project-related and organizational-related factors on different dimensions of performance is different for SMEs and large construction firms. In fact, as we indicate later, the degree of impact of organizational-related factors is much higher than project-related factors. The project managers and decision makers need to understand these critical differences in order to manage the projects much better.

Salient findings from SME construction firms

1) RII scores (Table 5) were used to rank the variables in each construct (Sambasivan & Soon, 2007). Based on the rankings, the top three variables in each construct: (i) project-related factors -- Consultant, contractor and material-related factors; (ii) organizational-related factors -- Learning organization, organizational culture and leadership-related factors; and (iii) performance-related factors -- Safety, financial and quality-related factors.

2) The performance-related factors indicate different results when compared to other studies. For example, Alinaitwe et al. (2013), Sambasivan and Soon (2007), and Sambasivan et al. (2017) have shown time and cost performance to be the most important factors.

3) The regression analysis provides interesting results. Among the project-related factors, consultant-related factor has impact on safety performance; external factor has impact on quality performance; and use of project management tools and techniques has effect on cost performance. The positive impact of consultant-related factor indicates that the increased roles of consultants assist in improving the performance of projects in terms of safety performance. Nikumbh and Pimplikar (2014) have argued that effective and timely solutions to various challenges faced by the construction firms are very crucial for a project's success. The challenges faced by SMEs can be very different from large firms. According to Gunduz and Lantinen (2016), most of the safety-related accidents happen in projects managed by SME construction firms. The consultants, according to Sarda and Dewalkar (2016), can play a significant role in reducing accidents.

A negative impact of external factor on quality performance indicates that if there are increased problems related to weather, regulatory enforcements, and other unforeseen conditions at the project site, then the failure of the project to achieve quality performance occurs. For example, damages to the equipment and materials due to weather can impact the quality of the project. Many researchers have shown the impact of external factor on project quality in Malaysian construction industry (Bari et al., 2012; Musa et al., 2015).

The tools and techniques assist the project managers to plan and keep track of the project in terms of all dimensions of performance. According to Murphy and Ledwith (2007), proper use of tools and techniques is critical to the success of projects. Turk and Scherer (2010) have stated that the tools/techniques help SME project managers to execute and coordinate the projects more efficiently and thereby, controlling the costs.

Aquil (2013) has stated that SME construction firms require the use of tools/software for monitoring schedule for various contracts and contractual obligations. The current study concludes that the use of appropriate tools and techniques in SME construction firms can help achieve better cost performance.

4) Among the organizational-related factors, organizational culture-related factor has impact on time, cost, quality, and financial performances; and learning organization-related factor has impact on quality and financial performances. According to Yazici (2009), organizational culture drives the behavior of an entire organization. Belassi et al. (2007) and Vaidyanathan (2016) have established a strong link between culture and project success. The finding of the current study has vindicated the stand of earlier researchers on the role of culture. The changes that are taking place in the construction industry are fast and rampant. The changes necessitate the SME construction firms to learn and adapt and culture plays a dominant role in enabling a firm to be a learning organization (Cooke-Davis, 2002; Love et al., 2004; Tennant & Fernie, 2013).

5) The relative impacts of project-related and organizational-related factors on different dimensions of performance have an interesting implication. Based on literature, it was hypothesized that in SME construction firms, relative impact of project-related factors would be higher than organizational-related factors. The results are exactly the opposite. Except for safety performance, all performance indicators are significantly impacted by the organizational-related factors. Specifically, the factors are: organizational culture and learning organization.

Salient findings from large construction firms

1) RII scores (Table 6) were used to rank the variables in each construct (Sambasivan & Soon, 2007). Based on the rankings, the top three variables in each construct: (i) project-related factors – Labor and equipment, contractor, and consultant-related factors; (ii) organizational-related factors -- Learning organization, organizational culture and leadership-related factors; and (iii) performance-related factors -- Safety, financial and time-related factors. The first two performance indicators are similar to SMEs but the third indicator is different.

2) The regression results are different from those of SME construction firms. Among the project-related factors, contractor-related factor has impact on time and financial performances; labor and equipment-related factor has impact on cost performance; and use of project management tools/techniques has impact on time, quality, and safety performances. The contractors play a critical role in the construction industry.

3) Large construction firms employ multiple contractors for executing different portions of a project. Therefore, the success of a project depends upon the performance of the contractors (Marzook & El-Rasas, 2014; Sambasivan et al., 2017). Poor planning, poor site management, poor construction methods and inadequate experience of contractors can cause the projects to be delayed and therefore, can impact the time and financial performances of projects.

The construction projects are labor and equipment intensive. Based on CIDB's (2017) report, over 760,000 workers (skilled, semi-skilled, administration, construction workers, and managers) were employed in the construction industry in 2016 and more than one-third were foreign workers. The labor cost component of a building project often ranges from 30 to 50%, and can be as high as 60% of the overall project cost (Aziz, 2013). Therefore, it is not surprising that the cost performance is influenced by labor and equipment-related cost.

In large construction firms, the sheer complexity and the size of the projects necessitate effective use of project management tools and techniques to plan and execute projects successfully. Based on this study, the impact of using the right tools and techniques has more significant impact for large construction firms than SMEs. Murphy and Ledwith (2007) highlight the importance of using the appropriate tools and techniques for project success. The construction firms in Malaysia, irrespective of size, are required to obtain quality accreditation such as, ISO 9000, ISO 14000, and ISO 21500 (Keng & Kamal, 2016) and occupational safety and health (OSH) accreditation to bid for and execute national and international construction projects. These accreditations mandate the construction firms to use relevant project management tools and techniques to effectively plan, design, control, and monitor the projects. It is conceivable that in large construction firms, use of tools and techniques has impact on time, safety, and quality performances of projects.

4) Among the organizational-related factors, organizational culture has impact on time, cost, quality, and safety performances; innovation has impact on safety performance; and learning organization-related factor has impact on all dimensions of project performance. The impact of organizational-related factors has been significant in large construction firms when compared to SMEs.

5) Many researchers have studied the impact of organizational culture on the performances of construction firms (Ankrah & Langford, 2005; Molenaar et al., 2009; Nguyen & Watanabe, 2017; Phua & Rowlinson, 2003). Nguyen and Watanabe (2017), based on their study on construction firms in Vietnam, have highlighted a positive link between culture and project performance.

Innovation has a negative regression coefficient with safety performance (Refer Table 8). Based on the meaning of scores, high score indicates that the construction firms do not favor innovation. Therefore, it can be concluded that if large construction firms favor innovation, then the safety performance becomes better. According to Esmaeili and Hallowell (2011), safety performance in the construction industry has improved significantly due to innovation in safety equipment, safety procedures, and safety training. As stated earlier, large construction firms have the necessary resources, skills, manpower, and funds to innovate. Therefore, innovation has recorded a significant impact on safety performance in this study.

Of the four organizational-related factors, learning organization has shown the significant effect on all dimensions of performance. Fong and Yip (2006) have argued that the capacity of the construction firms to learn and adapt is critical for the success of projects. According to Chinowsky et al. (2007), learning organization culture must reside within construction firms. The enhancement of this culture can take place with the proper implementation of knowledge management systems (KMS). Zhai, Liu and Fellows (2014) have argued that learning capability provides competitive advantage for construction firms and urged the firms to develop systems and practices that can assist firms to learn. In fact, it is the learning culture that leads to significant innovation (Vakola & Rezgui, 2000).

6) The relative impacts of project-related and organizational-related factors on different dimensions of performance are as hypothesized. This study has shown that for large firms, organizational-related factors have stronger impact than project-related factors. This result is not surprising given the fact that large firms have necessary resources, skills, manpower, systems, processes, and funds to derive maximum advantage from culture, innovation, and learning capability.

Theoretical and practical implications

This research has accomplished two important results that can increase our comprehension regarding the construction industry in general and specifically, in Malaysia. First, the size of the construction firms does matter while analyzing the critical success factors and different dimensions of performance. This study is one the very few that has tested a comprehensive model. The motivation for the model came from the research by Sekar et al. (2018). But their research used size of the firm as the control variable. Our research has delineated the SME and large construction firms and has vindicated our stand that success factors are different. This is a significant contribution to the body of knowledge.

Second, organizational-related factors, relatively have a higher impact than project-related factors on different dimensions of performance. Earlier studies in the construction industry have predominantly concentrated on project-related factors to study the impact on different dimensions of performance. Interestingly, organizational culture and learning organization factors have turned out to be significant for multiple dimensions of performance for SME and large construction firms. This finding is significant to academicians and practitioners. Studying construction industry performance without considering organizational-related factors is not tenable. In fact, both project-related and organizational-related factors should be included to understand the impact on performance.

The practical implications are many. First, the roles played by the contractors and consultants in ensuring successful completion of projects are very critical. The contractors are important for large construction firms and consultants have to guide SMEs. The managers must ensure that the contractors and consultants with excellent skills and track record are selected. Selection of contractors and consultants based on lowest bid can lead to potential project failures. Second, optimum selection and utilization of labor and equipment are significant for large firms to control costs. Third, the managers must optimize the utilization of project management tools and techniques that are available. Effective utilization of tools and techniques by SMEs and large construction firms can help the project managers to plan and keep track of the project in terms of various dimensions of performance. Fourth, the impact of external factors on the SMEs can be disastrous.

The managers must have a risk management system in place to mitigate the negative effects. Fifth, the managers must assist the project team in understanding the culture of the organization by organizing formal and informal meeting sessions and this applicable for firms of all sizes. Sixth, 'retrospection' sessions must be organized on a regular basis to capture the learnings at different stages in the life cycle of the projects executed by SMEs and large construction firms. Systematic storing and retrieval of this information through a knowledge management system (KMS) can help the firms plan, innovate and execute the projects effectively (Zhai et al., 2014).

Conclusions and limitations

This research has deviated significantly from the previous research from the following perspective: by combining project-related and organizational-related factors in a single framework and analyzing the impacts of factors on five dimensions of project performance (cost, time, quality, safety, and financial) and comparing the impacts based on firm size (SMEs and large construction firms).

The important findings are: (1) the impact of project-related and organizational-related factors are different for SMEs and large construction firms and for different dimensions of project performance; (2) among the project-related factors -- the significant factors for SMEs are: consultant-related, external, and use of project management tools and techniques; the significant factors for large construction firms are: contractor-related, labor and equipment-related and use of project management tools and techniques; and (3) among the organizational-related factors -- the significant factors for SMEs are: organizational culture and learning organization; the significant factors for large firms are: organizational culture, innovation and learning organization. Analyzing the relative impact of two factors, organizational-related factors have greater impact on SMEs and large firms than project-related factors. The limitations of this research are: (1) sample sizes are low for SMEs because of small population, (2) all the responses have been obtained from project managers/directors and the results may be different if other stakeholders are considered, and (3) the study is a cross-sectional study and a longitudinal study can be done to provide better cause-effect relationships.

References

Ali, M. A., Abdul-Rahman, H., Asef, A. (2017). Influence of Organizational Learning and Firm Size on Risk Management Maturity, *Journal of Management in Engineering*, 33(6), 1-9.

Alinaitwe, H., Apolot, R., & Tindiwensi, D. (2013). Investigation into the Causes of Delays and Cost Overruns in Uganda's Public Sector Construction Projects, *Journal of Construction in Developing Countries*, 18(2), 33-47.

Alsharkas, Z. (2014). Firm Size, Competition, Financing and Innovation, *International Journal of Management and Economics*, 44, 51–73.

Ananatatmula, V. S. (2010), Project Manager Leadership Role in Improving Project Performance, *Engineering Management Journal*, 22(1), 13-22.

Anikeeff, M. A., & Sriram, V. (2008). Construction management strategy and developer performance, *Engineering, Construction and Architectural Management*, 15(6), 504-513.

Aquil, M.A. (2013). Project Management in SMEs. *Journal of Strategy and Performance Management*, 1(1), 8-15.

Arias-Aranda, D., Minguela-Rata, B., & Rodríguez-Duarte, A. (2001). Innovation and firm size: an empirical study for Spanish engineering consulting companies, *European Journal of Innovation Management,* 4(3), 133-142,

Arditi, D., Nayak, S., & Damci, A. (2017), Effect of organizational culture on delay in construction, *International Journal of Project Management*, 35(2), 136-147.

Aziz, R. F. (2013). Factors causing cost variation for constructing wastewater projects in Egypt, *Alexandria Engineering Journal*, 52(1), 51-66 .

Beyene, K. T., Shi, C. S., & Wu, W. W. (2016), The impact of innovation strategy on organizational learning and innovation performance: Do firm size and ownership make a difference? *South African Journal of Industrial Engineering*, 27(1), 125-136.

Belassi, W., Kondra, A. Z., & Tukel, O. I., (2007). New Product Development Projects: The effects of organizational culture, *Project Management Journal*, 38 (4), 12-24.

Belout, A., & Gauvreau, C. (2004). Factors influencing project success: The impact of human resource management. *International Journal of Project Management*, 22, 1-11.

Bronte, S.M. (2015). Beyond the Iron Triangle: Evaluating Aspects of Success and Failure using a Project Status Model. *Journal of Computing & Information Systems*, *19*(2), 21-37.

Cheung, S.O., Suen, H.C., & Cheung, K.K. (2004). PPMS: A web-based construction project performance monitoring system. *Journal of Automation in Construction*, 13(3), 361-376.

Chinowsky, P., Molenaar, K., & Realph, A. (2007), Learning Organizations in Construction, *Journal of Management in Engineering*, 23(1), 27-34.

Cho, V. (2007). A Study of the Impact of Organizational Learning On Information System Effectiveness, *International Journal of Business and Information*, 2(1), 127-157.

CIDB (2017). http://www.cidb.gov.my/images/content/international/Malaysia----Country-Report-2017--22nd-Asia-Construct.pdf.

Department of Statistics, Malaysia. Can be accessed at: https://www.dosm.gov.my/.

Dubois, A., & Gadde, L.E. (2002). The construction industry as a loosely coupled system: Implications for productivity and innovation. *Journal of Construction Management and Economics*, 20(7), 621-631.

Egbu, C. O. (2004), Managing knowledge and intellectual capital for improved organizational innovations in the construction industry: an examination of critical success factors, *Engineering, Construction and Architectural Management*, 11(5), 301-315.

Esmaeili, B., & Hallowell, M. R. (2011), Diffusion of safety innovations in the construction industry, *Journal of Construction Engineering and Management*, 138(8), 955-963.

Fabiano, B., Currò, F., & Pastorino, R. (2004). A study of the relationship between occupational injuries and firm size and type in the Italian industry, *Safety Science*, 42(7), 587-600.

Gambatese, J. A., & Hallowell, M. (2011). Enabling and measuring innovation in the construction industry, *Construction Management and Economics*, 29(6), 553-567.

Gunduz, M., & Laitinen, H. (2017). A 10-step safety management framework for construction small and medium-sized enterprises, *International Journal of Safety Ergonomics*, 23(3), 353-359.

Guo, H. L., Li, H., & Li, V., (2013). VP-based safety management in large-scale construction projects: A conceptual framework, *Automation in Construction*, 34, 16-24.

Jha, K.N & Iyer, K. C. (2006). Critical Factors Affecting Quality Performance in Construction Projects. *Total Quality Management*, 17(9), 1155–1170.

Kaliba, C., Muya, M., & Mumba, K. (2009). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management, 27*(5), 522-531.

Kim, H. J., & Reinschmidt, K. F. (2012). Market Structure and Organizational Performance of Construction Organizations, *Journal of Management in Engineering*, 28 (2). 212-220.

Kleinknecht, A. (1989). Firm size and innovation, *Small Business Economics*, 1(3), 215–222.

Lee, J. (2009). Does Size Matter in Firm Performance? Evidence from US Public Firms, 16(2), 189 – 203.

Lejarraga, J. & Martinez-Ros, E. (2014). Size, R&D productivity and decision styles, *Small Business Economics*, 42(4), 643-662.

Leung, D., Meh, C., & Terajima, Y. (2008). Productivity in Canada: Does Firm Size Matter? *Research Department Bank of Canada Review*, AUTUMN, 5-14.

Lua, W., Zhang, L., & Pan, J. (2014), Identification and analyses of hidden transaction costs in project dispute resolutions. *International Journal of Project Management*, 33(3), 711-718.

Marx, T. G. (2017), The Impacts of Company Size on Leadership, *Management and Organizational Studies*, 4 (1), 82-89.

McVittie, S. D., Banikin, H., & Brocklebank, W. (1997). The effects of firm size on injury frequency in construction, *Safety Science*, 27(1), 19-23.

Molenaar, K. R., Park, J. I., & Washington, S. (2009), Framework for Measuring Corporate Safety Culture and Its Impact on Construction Safety Performance, *Journal of Construction Engineering and Management*, 135(6), 1 – 15.

Mosly, I. (2015), Safety Performance in the Construction Industry of Saudi Arabia, *International Journal of Construction Engineering and Management*, 4(6), 238-247.

Müller, R., & Turner, J. R. (2007). Matching the project manager's leadership style to project type, *International Journal of Project Management*, 25(1), 21-32.

Nguyen, L. H., & Watanabe, T. (2017), The Impact of Project Organizational Culture on the Performance of Construction Projects, *Sustainability*, 9(5), 781-790.

Nikumbh, A. R., & Pimplikar, S. S. (2014), Role of Project Management Consultancy in Construction Project, *IOSR Journal of Mechanical and Civil Engineering*, 10(6), 14-19.

Nixon, P., Harrington, M., & Parker, D. (2012). Leadership performance is significant to project success or failure: A critical analysis. *International Journal of Productivity and Performance Management*, *61*(2), 204-216.

Nooteboom, B. (1993). Firm size effects on transaction costs. *Small Business Economics*: *An International Journal,* 5, 283-295.

Oliveira, M. A., Valentina, L. V. O. D., & Possamai, O. (2012), Forecasting project performance considering the influence of leadership style on organizational agility, *International Journal of Productivity and Performance Management*, 61(6), 653-671.

Pagano P. (2003), Firm Size Distribution and Growth, *Scandinavian Journal of Economics*, 105, 255-274.

Park, Y. I., & Papadopoulou, T. C., (2012). Causes of cost overruns in transport infrastructure projects in Asia: Their significance and relationship with project size, *Built Environment Project and Asset Management*, 2(2), 195-216.

Plehn-Dujowich, J. M. (2009). Firm size and types of innovation, *Economics of Innovation and New Technology*, 18(3), 205-223.

Pollack, J. (2007). The changing paradigms of project management. *International Journal of Project Management*, 25(3), 266-274.

Roxas, B., Battisti, M., & Deakins, D. (2014). Learning, innovation and firm performance: knowledge management in small firms, *Knowledge Management Research & Practice*, 12(4), 443-453.

Sadaba, S. M., Ezcurdia, A. P., Lazcano, A. W. E., & Villaneuva, P. (2014). Project risk management methodology for small firms, *International Journal of Project Management*, 32(2), 327-340.

Sambasivan, M., & Soon, Y.W. (2007). Causes and effects of delays in Malaysian construction industry, *International Journal of Project Management*, 25(5), 517-526.

Sambasivan**,** M., Deepak, T.J., Ali, S., & Ponniah, V. (2017). Analysis of delays in Tanzanian Construction Industry: Transaction Cost Economics (TCE) and Structural Equation Modelling (SEM) approach. *Engineering, Construction and Architectural Management*, 24(2), 308-325.

Sarda, A., & Dewalkar, S. (2016), Role of management consultancy in construction, *International Journal of Technical Research and Applications*, 4(2), 317-320.

Saunila, M. (2014), Innovation capability for SME success: Perspectives of financial and operational performance, *Journal of Advances in Management Research*, 11(2), 163.

Sekar, G., Viswanathan, K., & Sambasivan, M. (2018). Effects of project-related and organizational-related factors on five dimensions of project performance: a study across the construction sector in Malaysia, *Engineering Management Journal*.

Senge, P.M. (1990), *The Fifth Discipline*. London: Century Business.

Swies, G., Swies, R., Abu Hammad, A., Shboul, A. (2008). Delays in construction projects: The case of Jordan, *International Journal of Project Management*, 26, 665-674.

Tabish, S. Z. S. & Jha, K. N. (2015), Important factors for success of public construction projects, *IPEDR*, 15, 64-68.

Turk, Z., & Schrer, R. (2010). eWork and eBusiness in Architecture, Engineering and Construction edited by Z. Turk, R. Scherer Proceedings of the European Conference on Product and Process Modelling 2010, CRC Press Boca Raton: Florida.

Turner, R., Ledwith, A., & Kelly, J. (2010). Project management in small to medium-sized enterprises: Matching processes to the nature of the firm, *International Journal of Project Management*, 28(8), 744-755.

Vaidyanathan, G. (2016). A framework for project culture in organizations, *Issues in Information Systems*, 17(II), 142-149.

Vakola, M., & Rezgui, Y. (2000). Organisational learning and innovation in the construction industry, *The Learning Organization*, 7(4), 174-184.

Vargas, J. P. M. (2015). Identifying Binding Constraints to Growth: Does Firm Size Matter?, *IMF Working Paper WP/15/3 Research Department*.

Walker, D. H. T. (2016), Reflecting on 10 years of focus on innovation, organisational learning and knowledge management literature in a construction project management context", *Construction Innovation*, 16(2), 114-126.

Welling, D. T., & Kamann, D. J. F., (2001), Vertical Cooperation in the Construction Industry: Size Does Matter, *Journal of Supply Chain Management*, 37(3), 28-33.

Xue, x., Zhang, R., Yang, R., Dai, J. (2014). Innovation in Construction: A Critical Review and Future Research, *International Journal of Innovation Science*, 6(2), 111-126,

Yazici, H. J. (2009). The role of project management maturity and organizational culture in perceived performance. *Project Management Journal*, 40(3), 14—33.

Yoo, S., & Kim, J. (2015), The Dynamic Relationship between Growth and Profitability under Long-Term Recession: The Case of Korean Construction Companies, *Sustainability*, 7, 15982–15998.

Zeng, K., & Luo, X. Impact of ownership type and firm size on organizational culture and on the organizational culture-effectiveness linkage, *Journal of Business Economics and Management*, 14(1), S96-S111..

Table 1 Research questionnaire sources

Variable	Author	Source of the Questionnaire	Reliability
Project-related factors	Sambasivan & Soon (2007)	Causes and effects of Malaysian construction industry.	0.88 – 0.97
Organizational-related factors: Leadership	Antonakis, Avolio & Sivasubramaniam (2003)	Context and leadership: An examination of the nine-factor full-range leadership theory using the multifactor leadership questionnaire.	0.71 – 0.90
Organizational-related factors: organizational culture	Abdul Rashid, Sambasivan & Abdul Rahman (2004).	The influence of organizational culture on attitudes toward organizational change.	0.67 – 0.92
Organizational-related factors: innovation	Trigo, Calapez & Santos (2009)	SMEs and internationalization: An empirical study of SMEs in Portugal.	0.64 – 0.82
Organizational-related factors: learning organization	Song (2009)	The dimensions of learning organization questionnaire (DLOQ): A validation study in a Korean context.	0.71 – 0.91
Project performance-related factors	Cheung, Suen & Cheung (2004)	PPMS: A web-based construction project performance monitoring system.	0.72 – 0.83

Table 2. Interpretation of questionnaire scores

Variable	Meaning of high score
Client-related factor	More problems due to client.
Contractor-related factor	More problems due to contractors.
Consultant-related factor	Role of the consultant is more important.
Material-related factor	More problems due to materials.
Labor & equipment-related factor	More problems due to labor & equipment.
Contract management-related factor	More problems due to contract management.
Externally-related factor	More problems due to externally-related factors.
Project management tools/techniques-related factor	Organization provides more support for implementation of project management tools.
Leadership-related factor	Leadership is favorable for an employee empowerment.
Organizational culture-related factor	Organizational culture plays an important role in all activities of the organization.
Innovation-related factor	Organization does not favor innovation
Learning organization-related factor	Organization favors learning organization initiatives.
Time performance	Organization achieves time performance in projects.
Cost performance	Organization achieves cost performance in projects.
Quality performance	Organization achieves quality performance in projects.
Safety performance	Organization achieves safety performance in projects.
Financial performance	Organization achieves financial performance in projects.

Table 3 Correlation Table

Factor	CR	AVE	1	2	3	4	5	6	7	8	9	10	11	12
1	0.84	0.56	1	0.63*	0.38*	0.36*	0.41*	0.47*	0.21*	-0.01	0.07	0.02	0.07	0.02
2	0.88	0.54	0.40	1	0.51*	0.49*	0.57*	0.54*	0.30*	0.06	0.03	-0.01	0.09	0.01
3	0.88	0.64	0.14	0.26	1	0.49*	0.43*	0.49*	0.35*	0.18*	0.19*	0.12^	0.13^	0.07
4	0.84	0.58	0.13	0.24	0.24	1	0.53*	0.54*	0.32*	0.19*	0.11^	0.19*	0.12^	0.11^
5	0.87	0.59	0.17	0.32	0.18	0.28	1	0.61*	0.23*	0.11^	0.07	0.07	0.06	-0.01
6	0.84	0.52	0.22	0.29	0.24	0.28	0.37	1	0.29*	0.12^	0.10^	0.05	0.09	-0.03
7	0.85	0.59	0.04	0.09	0.12	0.10	0.05	0.08	1	0.28*	0.17*	0.19*	0.19*	0.12^
8	0.91	0.71	0.00	0.01	0.03	0.04	0.01	0.1	0.08	1	0.10^	0.33*	0.17*	0.34*
9	0.93	0.46	0.01	0.00	0.04	0.01	0.01	0.01	0.03	0.01	1	0.45*	0.49*	0.21*
10	0.93	0.46	0.00	0.00	0.01	0.04	0.01	0.00	0.04	0.11	0.20	1	0.51*	0.47*
11	0.87	0.46	0.01	0.01	0.02	0.01	0.01	0.01	0.04	0.03	0.24	0.26	1	0.40*
12	0.92	0.45	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.12	0.04	0.22	0.16	1
13	0.87	0.65	-0.01	-0.11	0.10	0.11	0.03	0.05	0.07	0.31*	0.15^	0.43*	0.21*	0.42*
14	0.83	0.50	-0.02	-0.05	0.01	0.05	0.03	-0.04	0.03	0.25*	0.24*	0.48*	0.30*	0.42*
15	0.92	0.68	0.00	-0.01	0.09	0.10^	0.03	0.05	-0.03	0.27*	0.12^	0.34*	0.14^	0.35*
16	0.89	0.62	0.07	0.04	0.21*	0.12^	0.05	0.02	0.12^	0.33*	0.14^	0.31*	0.11^	0.32*
17	0.89	0.68	0.01	-0.04	0.05	0.10	0.05	0.07	0.05	0.19*	0.22*	0.39*	0.31*	0.43*

*significant at 0.01 level; ^significant at 0.05 level; values below the diagonal denote squared correlations

Legend: 1 – client-related, 2 – contractor-related, 3 – consultant-related, 4 – material-related, 5 – labor & equipment-related, 6 – contract-related, 7 – external-related, 8 – PM tools/techniques-related, 9 – leadership, 10 – organizational culture, 11 – innovation, 12 – learning organization, 13 – time performance, 14 – cost performance, 15 – quality performance, 16 – safety performance, 17 – financial performance, CR – composite reliability, AVE – average variance extracted.

Table 4 Descriptive statistics

Factor	# of items	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
Client-related	4	4	20	14.11	3.04	-0.66	0.40
Contractor-related	6	9	30	22.82	3.85	-0.85	0.89
Consultant-related	4	7	20	15.17	2.44	-0.735	0.725
Material-related	4	5	20	15.01	2.89	-0.45	0.22
Labor and equipment-related	4	8	20	15.12	2.76	-0.553	0.167
Contract-related	5	10	25	18.35	3.12	-0.260	-0.172
External-related	4	4	20	13.81	2.68	-0.205	0.197
PM tools / techniques-related	4	7	20	14.64	2.68	-0.365	0.123
Leadership	18	31	79	55.22	6.61	0.151	1.397
Organizational culture	23	40	77	55.55	6.02	0.211	0.238
Innovation	12	19	45	29.91	3.88	0.445	0.568
Learning organization	20	20	83	61.05	8.38	-0.660	1.252
Time performance	5	7	20	14.17	2.58	-0.162	0.123
Cost performance	5	8	25	16.70	2.73	-0.036	0.457
Quality performance	5	6	25	17.79	3.00	-0.412	0.869
Safety performance	5	10	25	20.10	2.89	-0.377	0.549
Financial performance	4	7	20	14.71	2.24	0.024	0.351

Table 5. Relative Importance Index Analysis – SME construction firms

Variable	RII Score	RII Ranking
Project-related factors (IV1)		
Client-related factor	0.6993	7
Contractor-related factor	0.7592	2
Consultant-related factor	0.7610	1
Material-related factor	0.7535	3
Labor and equipment-related factor	0.7447	4
Contract-related factor	0.7362	5
Externally-related factor	0.6938	8
Project management tools/techniques-related factor	0.7303	6
Organizational-related factors (IV2)		
Leadership-related factor	0.6643	3
Organizational culture-related factor	0.6903	2
Innovation-related factor	0.6557	4
Learning organization-related factor	07120	1
Project Performance (DV)		
Time-related performance	0.6916	4
Cost-related performance	0.6533	5
Quality-related performance	0.7014	3
Safety-related performance	0.8176	1
Financial-related performance	0.7315	2

Table 6. Relative Importance Index Analysis – large construction firms

Variable	RII Score	RII Ranking
Project-related factors (IV1)		
Client-related factor	0.7136	7
Contractor-related factor	0.7627	2
Consultant-related factor	0.7516	3
Material-related factor	0.7465	4
Labor and equipment-related factor	0.7705	1
Contract-related factor	0.7146	6
Externally-related factor	0.6864	8
Project management tools/techniques-related factors	0.7382	5
Organizational-related factors (IV2)		
Leadership-related factor	0.6947	3
Organizational culture-related factor	0.6997	2
Innovation-related factor	0.6764	4
Learning organization-related factor	0.7262	1
Project Performance (DV)		
Time-related performance	0.7318	3
Cost-related performance	0.6874	5
Quality-related performance	0.7202	4
Safety-related performance	0.7856	1
Financial-related performance	0.7442	2

Table 7. Regression analysis – SME construction firms

	Dependent variable			
Independent variable	**Time**	**Cost**	**Quality**	**Safety**
Project-related Factors (IV1)				
Client-related factor	0.138#	0.120	-0.015	0.105
Contractor-related factor	-0.196	0.081	0.014	-0.072
Consultant-related factor	0.119	-0.118	0.198	0.423**
Material-related factor	-0.008	-0.076	0.154	-0.073
Labor and equipment-related factor	0.080	-0.166	0.007	0.150
Contract-related factor	0.117	-0.124	0.083	-0.137
Externally-related factor	-0.200	-0.096	-0.334**	0.051
Project management tools/techniques-related factor	0.162	0.276**	0.203	0.160
Organizational-related Factors (IV2)				
Leadership-related factor	-0.040	0.030	0.026	0.013
Organizational culture-related factor	0.143**	0.139**	0.131**	0.063
Innovation-related factor	-0.014	-0.004	-0.070	0.026
Learning organization-related factor	-0.048	0.038	0.097**	0.070
R^2Value	0.331	0.351	0.381	0.275
Adjusted R^2 Value	0.246	0.269	0.302	0.182
Adjusted R^2 contribution of IV1 and IV2 in %age	IV1 = 36% IV2 = 64%	IV1 = 38% IV2 = 62%	IV1 = 43% IV2 = 57%	IV1 = 64% IV2 = 36%
F Value	3.882	4.243	4.823	2.965
P Value	0.000	0.000	0.000	0.002

**Significant at 0.05 level of significance; # -- unstandardized coefficient value

Table 8. Regression analysis – large construction firms

	Dependent variable			
Independent Variable	**Time**	**Cost**	**Quality**	**Safety**
Project-related Factors (IV1)				
Client-related factor	0.035#	-0.049	-0.044	0.051
Contractor-related factor	-0.157**	-0.067	-0.023	-0.065
Consultant-related factor	0.083	-0.038	-0.024	0.136
Material-related factor	0.076	-0.060	-0.087	-0.014
Labor and equipment-related factor	-0.010	0.177**	0.010	-0.019
Contract-related factor	0.071	0.010	0.098	0.006
Externally-related factor	-0.032	-0.064	-0.076	-0.047
Project management tools/techniques-related factor	0.173**	0.061	0.163**	0.166**
Organizational-related Factors (IV2)				
Leadership-related factor	-0.034	-0.002	-0.030	-0.022
Organizational culture-related factor	0.080**	0.091**	0.060**	0.102**
Innovation-related factor	0.010	0.022	-0.029	-0.122**
Learning organization-related factor	0.080**	0.075**	0.060**	0.061**
R^2Value	0.309	0.290	0.151	0.266
Adjusted R^2 Value	0.272	0.252	0.105	0.226
Adjusted R^2 contribution of IV1 and IV2 in %age	IV1 = 49% IV2 = 51%	IV1 = 24% IV2 = 76%	IV1 = 39% IV2 = 61%	IV1 = 47% IV2 = 53%
F Value	8.205	7.504	3.273	6.629
P Value	0.000	0.000	0.000	0.000

**Significant at 0.05 level of significance; # -- unstandardized coefficient value

Rice Hulls as Solid Pellet Fuel for Energy Generation

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A *presentation for creating awareness of the export potential of our locally available abundant biomass resources, particularly rice hulls wastes as solid fuel pellets for much needed environment-friendly fuel for energy generation. A project with co-benefits for Entrepreneurs first- and the Business Community at large and also Sri Lanka as a whole.*

Abstract

Rice is the staple diet of over half the population of the world and at an estimated production volume of well over 800 million metric tonnes per annum, the second largest produced cereal in the world. Rice grows from tropics to sub-tropical to warm temperate countries up to 400S and 500N of the equator. Four major environments are associated with rice growing as: irrigated, rain-fed lowlands, Upland and flood prone. 50% of grown rice is consumed by China and India and until a few years ago, the rice hulls (husks) resulting from *hulling* has been considered an agricultural waste and used only in a few small applications.

However, due to diligent research, the full potential of this valuable commodity is being realized and three significant products are being manufactured- polymeric composite resins, polymeric lumber as an ideal substitute for natural wood and more recently- rice hulls pellets as an alternative for diesel and coal as fuel. While the first two are made from combinations of rice hulls flour and polymer resins, the last one is made by a process of compression with suitable small quantities of additives primarily for adhesion. The resulting solid ash and the flue ash from combustion of rice hull pellets will have many end applications such as: road paving component, Portland cement component, filler for bricks, roofing tiles, extraction of silica (>70%), fertilizer, spill absorbents, filtration and many others. Rice Hulls are an ideal feedstock for producing bio-diesel also and thermochemical processes like *pyrolysis* and *gasification* methods can be used for this purpose.

Keywords: Combustion; Compression; Pellets; Rice Hulls; Solid Biomass Fuel;

Introduction

As the world battles severe climate change issues with escalating environmental concerns, phasing out petro-based products has seen some significant mechanisms, although some may say that it is still too slow. The use of biomass by most countries to replace traditional petroleum- based feedstocks is encouraging, with the energy sector being one of the biggest beneficiaries.

In the context of environmental issues, it would be prudent to remember the slogan-"*Out of the earth is harmful- from the earth is plentiful",* meaning what we dig or extract out of the earth is harmful as a whole for the planet, while scientists and researchers have been realizing the value of the millions of tons of biomass being generated which can be used as feedstock for most of our needs.

One of the most needed by humans are energy sources and wood pellets are replacing traditional fuels such as diesel and coal which generates high percentages of carbon dioxide which depletes the earth's protective layer of ozone, thus being a major contributing factor for climate change. The argument that wood pellets made from wood waste is acceptable, while deforestation is not acceptable is debatable.

However, a huge expanding market exists for wood pellets. In Canada, Pinnacle Renewable Energy Company (Edmonton) with an annual production of over 1.5 million metric tons is now planning an additional annual production capacity of 475.000 metric tons of wood pellets.

This is in anticipation of expanding market demand covering Europe and Asia as more and more countries are taking advantage of the carbon neutrality of wood pellets. With several companies manufacturing and exporting wood pellets, Canada's revenue is around 300 billion dollars per annum.

Japan and South Korea are the largest importers of wood pellets in Asia with around 650,000 tons per annum, while next in line are UK, Denmark and Europe. Vietnam was the biggest exporter of wood pellets to Asian countries but with countries like Canada and USA coming in, their volumes are a little lower.

Although Sri Lanka may not have huge resources of wood wastes, nor can ill-afford cutting down trees for wood pellets, there is an abundance of agricultural-wastes available in very large volumes led by rice hulls (husks) which can be converted into biomass pellets for fuel sources for energy generation. These pellets will have a much higher calorific value than wood pellets, although the carbon imprint will be slightly higher than wood. Rice hulls pellets will afford an additional benefit in that the resulting ash can be used as components for road paving, Portland cement, roofing sheets, as filler/moisture barrier for cement bricks, extraction of silica, as filler finely ground rice hulls with moisture levels less than 2% for export to the West and Europe for the manufacture of polymeric composite lumber, which is gradually replacing the use of natural wood. This is of course, a well-established trend in Asia and the far -East.

What are Rice Hulls?

Rice hulls, also known as husks or chaff, are the outermost hard layers (shells) convex in shape, protecting the grains of paddy inside. These are separated after harvesting during a process called milling, which produces two types- rough and fine powder. As a major by-product of the rice milling industry, rice husks is one of the most commonly available lignocellulosic materials that can be made into solid pellets for use as fuel source and also converted into viable types of fuels and also chemical feedstocks through a variety of thermochemical conversion processes.

Rice Hulls Properties

Rice hulls are generally yellow in colour and convex in shape. Typical dimensions are 4mm x 6mm but variations are possible from different types of rice grains. It is light weight having a ground bulk density of around 300 – 400 kg/cu.m and it is estimated that about 20% of the paddy weight is husk. Rice husks contain 75 % organic matter such as lignin, cellulose and the rest is made up of minerals like silica and trace elements. The chemical composition of rice hulls will vary according to rice grain variety, soil chemistry, climatic conditions and even on the geographic location. A typical analysis of rice hulls is shown in the Table-A given below:

Properties	Range
Hardness (Mohr's scale)	5 – 6
Silica %	18 – 20
Ash %	22 - 29
Carbon %	30 – 35
Hydrogen %	4 – 5
Oxygen %	31 – 37
Nitrogen %	0.23 – 0.32
Sulphur %	0.04 – 0.08
Moisture %	9 – 12

Source: Researcher Center

Note: since most of the ash generated is deposited in the combustion chamber and even the particles from flue-gas is directed down to earth, only a very small percentage will escape into the air.

Rice husk is usually high in ash content as compared to other biomass fuels in the range of 10-20%. This ash contains about 70% silica, highly porous and light weight, with a very high external surface area. Presence of high content of silica makes it a valuable material for use in industrial applications, such as a moisture barrier or stiffening/strengthening component. Rice hulls from the fields in bulk could have high moisture contents from exposure to the elements and will need intense drying before use. However, rice hulls stored in shelter, will naturally contain less moisture and will need a lesser degree of drying. Due to its low density and unusual shape poses storage and transport challenges. For large volumes, storing in Silos is also an alternative but lumping could take place due to vertical weight.

Rice hulls which has been traditionally considered as a waste and either burned or dumped in landfills is now being considered as a material with great potential for industrial, consumer and building construction applications and with innovative thinking, many new avenues for uses are opening up.

Advantages of using RH Pellets

- Abundance of raw material
- Higher calorific value than wood
- Cheap material costs
- Much lower sulphur and nitrogen contents
- High calorific value
- Reduction in use of wood pellets
- Reduction in de-forestation
- Economically cheaper than using coal/diesel
- Can be used efficiently even for steam generation for nuclear plants
- Compatible with other suitable biomass as fuel for energy generation
- Ease of large volume manufacture
- Combustion ash and flue ash can be used for many other applications
- Heating and cooking with these pellets will ease the use of harmful petro-based products

Disadvantages

- Needs degree of drying to remove moisture, before use
- Needs to eliminate foreign matter from raw material
- Raw material storage is difficult. Needs large area
- Pellets difficult to ignite initially
- Needs efficient design to prevent fine flue particles escaping into air
- Difficult to transport bulk raw material from source to factory

Conversion to Pellets

The manufacture and use of rice hulls pellets has been in practice for a sometime, for example, in China and Vietnam and complete technology, machinery and turnkey projects are available from established sources from there and from Canada, who have advanced their technologies for wood pellets. Figure 1 below shows loose rice hulls vs. moulded pellets - sizes can vary from 6mm to 12 mm or more depending on the customer needs.

Figure 1 – Rice Hulls pellets from rice hulls

For export-oriented rice hull pellets to Europe and the West, the recommended international standards are: ASTM (American), BSS (British) or DIN (German). Machines shown below are for small volume productions and basic minimum requirements are: dryers, pulverisers (size reduction) and pelletizers for commercial productions. For large scale productions, for example, to set up a factory for export-oriented volumes, some of the essential basic machinery would be a rotary dryer, hammer mill, pulverisers, vibrating shifters, pellet mills, pellet coolers, packing machines and so on. Special attention is needed for planning storage for both raw material and finished products. Figure 2 below shows small volume rice hulls pellet making machines.

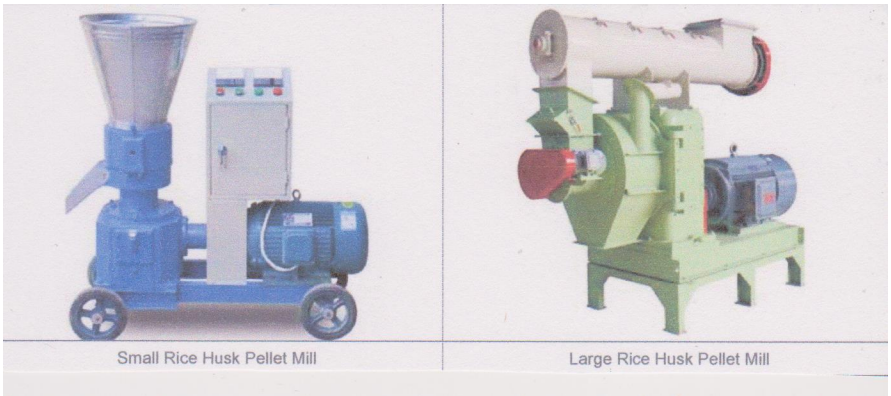

Figure 2, Photographs curtesy of GEMCO Rice Hulls Mills- China

Full scale projects from manual operations, semi-auto and fully automatic production lines are available from sources in China, Vietnam, Canada and some other countries. Most will offer complete turnkey projects including technology, machinery and equipment and project set up. There are also many suppliers of rice hulls and other biomass materials in any form you need, for example, loose leaf, powder, flour or ash. Some pellet producers may even opt to combine two or three biomass varieties for better combustion or cost-effectiveness. Three of the areas needing attention when setting up a pellet manufacturing project dies, which may tend to wear out fast, if a proper lubricant is not incorporated in the mix.

Biomass Electricity Generators

This is an interesting and exciting concept, especially when they are available as self-contained units capable of generating sufficient power to be of practical use. Although wood wastes in the form of pellets is probably the more popular biomass in the west, other biomass like rice hulls wastes, wheat hulls wastes and others will also be practical feedstocks with one big advantage of being available in huge quantities in most countries. Also the concept of mixtures of d (Placeholder2)ifferent biomass, contributing different component properties should be interesting as pellets for solid fuel utilization.

Figure 3- A self-constrained Biomass Generator (20 KW)

Photograph curtesy of All Power Laboratories, California, USA.

This revolutionary design by an engineer from California called the –Power Pallet- is a portable, self-contained, small plant is essentially a biomass refinery and generator which can easily produce 20 kilowatts of electricity.

Basically, the Power Pallet works by burning biomass but before the fuel is fully combusted, the resulting flammable gases like hydrogen and carbon monoxide are spirited away to be used instead as fuel in a General Motors engine that works as an electricity generator. The addition of a small quantity of Walnut shell powder/flour to a biomass would enhance efficiency but it is optional. According to technical data available, 10 kg. biomass converted to electricity by this biomass fuel could cost as little as one-third the cost of diesel per kilowatt hour generated. The provision of an automatic ash collection chamber which can be emptied periodically, makes this design truly remarkable.

Froling is a family-owned company in Austria, a pioneer in wood/biomass fired heating systems development. Their P4 boilers provide a convenient, cost-effective and easy to operate and environmentally responsible way to heat homes and provide hot water with biomass pellets as fuel. Homeowners are assured of unusually high heating efficiency, low heating costs and the ability to use abundantly available renewable fuel. With its fully automated operation, these are easy to use. Figure 4 below shows a biomass pellet boiler for heating residential buildings. When installed this unit or other similar models will have additional equipment in order to support a complete heating system. Photo provided- Figure 4 is curtsy of Froling (Austria).

Special Features

- Pneumatic pellet feed is ideally suited for bulk fuel applications, although P4 may be used with bagged fuel.
- Variable speed induced draft fan ensures optimal fuel-to-air ratio.
- Incoming combustion air temperature is raised with an integral pre-heating system.
- Cascade control system for multiple boiler systems.
- Multiple-pass heat exchanger and automatic cleaning provide maximum efficiency and exceptional fly ash separation.
- Integrated storage tank control.
- Rated outputs from36k BTU/hr to 200k BTU/hr
- Systems go up to 800k BTU/hr
- Exhaust temperature under 250 F
- Must be installed with a moderately sized buffer tank to reduce on/off cycling for optimal efficiency.
- Ash separation to two drawers
- Virtually silent operation

Technical Data Model 8 Model 15 Model20 Model 25 Model 32 Model 38 Model 48 Model60

Output	BTU/hr	35,800	50,800	68,200	85,300	109,000	129,650	163,800	200,000
Output	Kw	10.5	14.9	20.0	25.0	32.0	38.0	48.0	58.5
Heat output	Kw	3.1-10.5	3.1-14.9	6-20.0	7.5-25.0	8.9-32.0	8.9-38.0	14.4-48.0	17.3-58.5
Power @240V	W	96	123	110	110	110	110	120	120
Water	US gallons	18.5	18.5	21	21	33	33	45	45

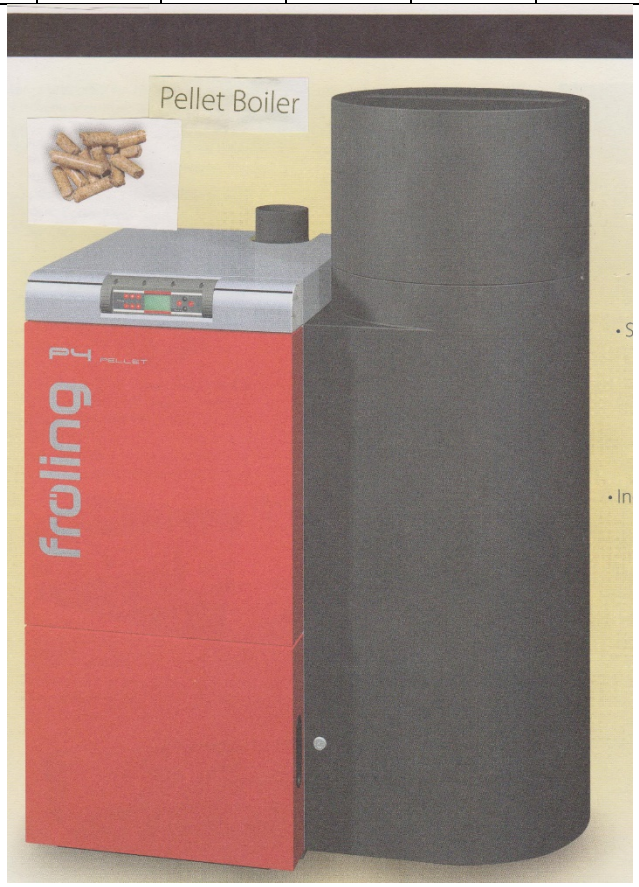

Figure 4 Biomass Boiler for Thermal Heat Generation for residential Pumps.

In the west, biomass electrical power generators producing standard 20 KW up to 200 KW are now on the market with research being done for larger power generations. These machines are self-contained and works on the principle of biomass pellets as fuel being converted to bio-diesel, which powers an inbuilt turbine generating electrical power. Where fuel energy is required for steam boilers, these solid pellets can be directly fed into the combustion chambers and the resulting solid ash and the flue ash should be collected via an efficient collecting system as this ash will have many viable uses. Even though the use of wood pellets is a great success as steam boiler fuel even for nuclear electrical power generation, de-forestation is not a feasible idea in the long run.

Additional Information

Since the machines presented above mostly works on the principles of pyrolysis and gasification, basic information is given below:

(a) **Pyrolysis**

Pyrolysis is the chemical decomposition of organic (carbon-based) materials through the application of heat. Pyrolysis is considered as the first step in combustion and gasification, which occurs in the absence or near absence of oxygen and thus is distinct from combustion (burning) which takes place only in the presence of oxygen. The rate of pyrolysis increases with temperature and in industrial applications the temperatures used are often about 430 C (about 800 F) or higher. In smaller-scale operations the temperature may be much lower.

Pyrolysis transforms organic materials into their gaseous components, a solid residue of carbon and ash and a liquid called *pyrolytic oil* or *bio-oil.* Pyrolysis has two primary methods for removing contaminants from a substance, destruction and removal. In destruction, the contaminants are broken down into compounds with lower molecular weights, whereas in removal process, they are not destroyed but are separated from the contaminated material.

Pyrolysis is a useful process for treating organic materials that ‘crack’ or decompose under the presence of heat. Although pyrolysis is a useful process for removing or destroying inorganic materials such as metals, it can be used in techniques that render those materials inert. A pyrolysis process has numerous applications of interest with regard to green technology. One of the most important is the production of *biofuel* from agricultural crop wastes, such as rice hulls.

(b) **Gasification**

Gasification is a flexible, reliable commercial technology that can turn a variety of low-value feedstocks like biomass into high-value products like electricity and biofuel. This will help reduce a country's dependence on imported oil and natural gas and can effectively provide a clean alternative sources of baseload electricity, fertilizers, fuels and chemicals.

It is a manufacturing process that converts any material containing carbon, such as –coal, petroleum coke, biomass or wastes- into syngas. This syngas can be burned to produce electricity or further processed to manufacture chemicals, fertilizers, liquid fuels, as substitutes for natural gas or hydrogen. Gasification has been reliably used on a commercial scale for many years worldwide in refining, fertilizer and chemical industries and more recently in the electrical power industry.

The type of feedstock more or less determines the design of the gasifier. In biomass gasification there are three basic designs- updraft, downdraft and cross-draft. In an updraft gasifier, the biomass enters the gasification chamber from above, falls onto a grate and forms a fuel pile. Air enters from the bottom through the grate and flows through the pile. The syngas, also known as producer gas in biomass industry, exits through the top of the chamber. In the other two systems, the air and syngas may enter and exit at different locations.

Bibliography

1. TARM Biomass-www.woodboilers.com
2. Make Rice Husk Pellets-www.gemcopelletmills.com
3. Bliss Industries LLC – www.bliss-industries.com
4. The Gasification Process-www.gasification-syngas.org/technology
5. Boslaugh, S.- Article on "Pyrolysis Chemical Reaction"-www.britannica.com/science/pyrolysis
6. Mack, Eric- article "Could this little-known biomass generator start an energy revolution?" May 27 2014
7. Defonseka, Chris- "Introduction to Polymeric Composites with Rice Hulls"-p 57-67 Smithers Rapra UK 2014

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