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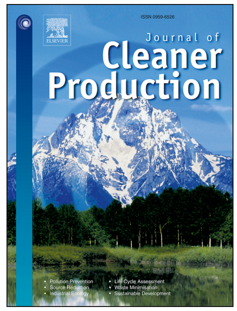

Explaining the impact of reconfigurable manufacturing systems on environmental performance: The role of top management and organizational culture

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Explaining the Impact of Reconfigurable Manufacturing Systems on Environmental Performance: the role of top management and organizational culture

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Abstract

This study develops a theoretical model that links reconfigurable manufacturing systems with top management beliefs, participation, and environmental performance, drawing on agency theory and organizational culture. The study takes into account the possible confounding effects of organization size and organizational compatibility. Drawing on responses from 167 top managers, the results of hypothesis testing suggest that (i) higher top management participation, being influenced by top management beliefs, leads to higher chances of RMS becoming adopted by organizations as their manufacturing strategy; (ii) organizational culture moderates the relationship between the level of top management participation and RMS (and manufacturing strategies) adoption; and (iii) higher re-configurability of manufacturing systems leads to better environmental performance. Furthermore, we integrate Agency Theory and organizational culture to explain the role of top management beliefs and participation in achieving environmental performance via RMS. Finally, we offer guidance to those managers who would like to engage in leveraging top management commitment for achieving environmental performance, and outline further research directions.

Keywords: Reconfigurable Manufacturing Systems, Environmental Performance, Agency Theory, Organizational culture.

1. Introduction

In recent years reconfigurable manufacturing systems (RMS) have attracted significant attention from both researchers and practitioners. RMS have been the answer to the pending past research calls, based on the ability of RMS to respond to the sudden market changes at lowest cost in comparison to flexible manufacturing systems (Bi et al., 2008; Rosio and Safsten, 2013). Furthermore, their ability to re-configure provides a unique advantage to RMS over flexible manufacturing systems or agile manufacturing systems in terms of cost and affordability (Singh et al., 2007; Koren and Shpitalni, 2010; Battaia and Dolgui, 2013). According to Garbie (2014), reconfiguration is related to changing different activities such as routing, scheduling, planning, programming of machines, controlling physical layout by adding and removing machines and their components, material handling systems, and configuration of work stations. RMS are used interchangeably with agile manufacturing, with the former emerging as one of the most popular manufacturing strategies to achieve agility and sustainable manufacturing (Garbie, 2013; 2014), and help in the survival of manufacturing systems (Molina et al., 2005).

While there is rich body of literature focusing on the design of RMS (see Hu et al., 2011; Garbie, 2013; 2014), research on the assimilation of RMS as well as their impact on environmental performance is scant. In particular, there is yet research to be conducted on under what conditions RMS can help improve the environmental performance of manufacturing firms. Scholars (see Abdi and Labib, 2003) have investigated the role of managers (plant manager, shop-floor manager and manufacturing designer) in achieving desired objectives (e.g. responsiveness, product cost, product quality, inventory, and operator skills). They used AHP to rank conventional manufacturing systems and reconfigurable manufacturing systems (RMS). Thus, the role of managers on environmental performance using RMS is not empirically validated. Furthermore, the role of organizational culture on lean and agile manufacturing has attracted significant contributions (see, Gunasekaran and Spalanzani, 2012; Pampanelli et al., 2013; Kurdve et al., 2014). Culture has been found to be an important factor in influencing supply chain management (SCM) practices and the adoption of systems (Liu et al., 2010). Notwithstanding (i) the importance of RMS as one of the manufacturing strategies to achieve agility in manufacturing firms; (ii) the endorsement of scholars to study the behavioural aspects of Operations Management (OM) and SCM concepts and related technologies (Gino and Pisano, 2008; Croson et al., 2013); and (iii) the important role of top management support and commitment as a cultural elements of shared values among supply chain organisations (Mello and Stank, 2005), and its link to environmental performance (Aragon-Correa et al., 2008; Boiral et al., 2009), there is yet research to be conducted on the impact of top management beliefs and practices and organizational culture on RMS, and the impact of the latter on environmental performance.

To address this gap, our study develops and tests a theoretical model to investigate the role of organizational culture in moderating the influence of top management beliefs and practices on RMS, and the impact of RMS on environmental performance. It is based on a survey with 167 top managers, drawing on Agency Theory (Eisenhardt, 1989) and organizational culture (Hofstedeet al., 1990; Bates et al., 1995; Jung et al., 2009). Notwithstanding their popularity in OM and SCM research (Ketokivi and Schroeder, 2004; Liu et al., 2010; Zhang et al., 2015), both lenses are yet to be used to explore agents' behaviour within RMS (Halldorsson and Skjott-Larsen, 2006; Ketchen and Hult, 2007; Fayezi et al., 2012). Our use of Agency Theory and organizational culture lenses resonates with Taylor and Taylor's (2009) entreaty to use alternative methods to explore new dimensions of the impact of OM and SCM.

The rest of the paper is organized as follows. In the next sections we present our literature review and the theoretical framework that integrates Agency Theory and organizational culture. Based on our framework we develop a research model, describe the operationalization of constructs and data collection, present the results of the model testing, and discuss the findings and their theoretical and managerial implications, as well as the research limitations. The paper concludes with a summary of the findings and future research directions.

2. Review of the literature on top management, reconfigurable manufacturing systems, and organizational culture

We have undertaken a review of the literature, which has been subsequently classified on the basis of building blocks of our theoretical framework as shown in Figure 1. The foundation of theoretical framework comprises two elements: human agency theory and organizational culture. We argue that top management beliefs and top management practices under the moderation effect of organizational culture will help to achieve desire outcome from RMS in improving environmental performance. Our theoretical framework as shown in Figure 1.

Figure 1 around here

The definitions of the basic concepts of our framework are extrapolated in Table 1 (it also includes the measures for each of our concepts, which will be introduced later in the paper).

Table 1 around here

2.1 Top management and reconfigurable manufacturing systems

Top management has been identified as a critical element in many kinds of development. While supply chain partners seek to implement sustainability and environmental practices (Liang et al., 2007; Gattiker and Carter, 2010; Foerstl et al., 2015), scholars (see Jabbour and Jabbour, 2016) have underlined that senior and mid-level managers' beliefs and practices are vital for adopting sustainable practices, for instance in green purchasing (Yen and Yen, 2012) and reverse logistics (Abdulrahman et al., 2014). However, there are yet no studies that discuss the influence of top management beliefs and practices on RMS as moderated by organizational culture.

To address this gap, we use Agency Theory (Eisenhardt, 1989). Agency Theory addresses those situations where in a contract one party (the 'principal') "delegates authority – in terms of control and decision-making about certain tasks – to another party (the agent)" (Fayezi et al., 2012: p.556). In OM and SCM, scholars have used Agency Theory to understand how supply chain members manage risks and relationships (e.g. Halldorsson and Skjott-Larsen, 2006). The principal-agent research stream of inquiry assumes that the principal and the agent will aim at maximising their positions through their different interpretations of the contract. Agency theory has been used to examine buyer-supplier relationships and mechanisms for achieving SCM effectiveness (Ketchen and Hult, 2007), and supply risk (Zsidisin and Ellram, 2003). Recent work has investigated conflicts of interest taking place within service triads and their effect on operational and financial performance (Zhang et al., 2015).

In investigating the role of top management and culture in RMS, we conceptualize top managers as principals that translate organizational goals into desired actions such as changing organizational structures, and establishing policies based on their perceptions and beliefs of market expectations. Agents (e.g. functional departments, trade unions, employee associations), due to their own views and agendas, will try to maximize their own benefits through their different interpretations of what is needed for RMS implementation and conflicts of interest may arise. In this paper we are interested in the managerial agency (principals) for RMS implementation since human agency has a significant role to play (Abdi and Labib, 2003). In dynamic environments, top managers are not only influenced by environmental uncertainty –characterized by demand uncertainty, supply uncertainty and technological uncertainty (Paille et al., 2014) -but also by the organizational culture, market expectations, government pressures, societal expectations and pressures by competitors (Qu et al., 2015; Shaukat et al., 2015). Prior studies have indicated a strong linkage between top management commitment and environmental performance (Boiral et al., 2009; Paille et al., 2014; Shaukat et al., 2015). For instance, Paille et al. (2014) have investigated the relationship between strategic HRM, environmental concern, organizational citizenship for the environment and environmental performance whereas Shaukat et al. (2015) have suggested that CSR oriented boards that develop proactive and comprehensive CSR strategies achieve superior environmental and social performance. However, there is scant literature on the impact of top management commitment on RMS.

2.2 Organizational culture, top management commitment and reconfigurable manufacturing systems

Organizational culture describes those knowledge structures used by organizations to perform tasks and generate social behavior (Smircich, 1983; Hofstede et al., 1990; Bates et al., 1995). Hence, organizational culture has to do with shared meanings within organizations that manifest during interactions between employees (Gregory, 1983). Hofstede et al. (1990) suggest that organizational culture impacts upon and is impacted upon by structures, role expectations, problem solving approaches, decision making routines and practices. It also impacts authority structures, tasks and rules, and coincides with Schein's (1985) view on culture and leadership/authority. In later studies, Ravasi and Schultz (2006) argued that organizational culture is set of shared mental assumptions, which guide the working behaviors within an organization. However, various conceptualizations of organizational culture have been proposed in the literature (Detert et al., 2000; Junget al., 2009).

Within OM and SCM, scholars have highlighted the role of organizational culture (Gunasekaran and Spalanzani, 2012; Pampanelli et al., 2013; Kurdve et al., 2014) and its influence on coordinated decision-making and decentralized authority within manufacturing strategy (Bates et al., 1995). Later studies (e.g. Baumgartner and Zielowski, 2007; Carter and Rogers, 2008) discussed, inter alia, the role of organizational culture as building block of sustainable supply chain management; lean management (Bortolottiet al., 2015), the intention to adopt internet-enabled supply chain management systems (Liu et al., 2012), supply chain disruption (Dowty and Wallace, 2010), supply chain integration (Cao et al., 2015), cultural fit and performance (Whitfield and Lenderos, 2006), and culture types, learning, and performance within organizations (Su and Chen, 2013) and supply chains (Cadden et al., 2013). However, apart from studies focusing on the relationship between culture, structure, and advanced manufacturing technologies (Zammuto and O'Connor, 1992; McDermott and Stock, 1999), and those looking at the role of culture in technology and information systems (see, Leidner and Kayworth, 2006), there is hardly any work focusing on RMS and organizational culture.

Past research has shown that organizational culture has a moderation effect on top management behavior (Boiral, 2009; Yiing and Ahmad, 2009; Renwick et al., 2012; Jabbour et al., 2013). Stone (2000) suggested that corporate culture plays a significant role in shaping attitudes of employees regarding cleaner production programs. However, scholars call for more research on the role of culture in influencing top management behaviors, especially focusing on environmental issues (Renwick et al., 2012). We are thus driven by the encouragement of Khanchanapong et al., (2014) to study the role of culture in the adoption manufacturing technologies for performance.

2.3 Reconfigurable manufacturing systems: impact on environmental performance

The RMS philosophy revolves around six core characteristics that include modularity, integrability, customized flexibility, scalability, convertibility and diagnosability (Landers et al., 2001). A typical RMS may possess some or all of these characteristics. However, these characteristics help RMS to be more responsive to any sudden change in market or sudden failure in equipment

(Mehrabi et al., 2000). Garbie (2013, 2014) has further outlined the significant impacts of RMS on sustainable enterprises. We therefore argue that RMS is one of the manufacturing strategies that help to achieve agility in manufacturing while keeping costs and waste to a minimum.

3. Research model and hypotheses

We develop our research model (Figure 2) and propose four hypotheses. Other factors may have confounding effects on interacting variables, a possibility that is considered during model testing and subsequent discussion.

3.1 Top Management beliefs and practices in embracing reconfigurable manufacturing systems

To understand top management commitment we elaborate on two conceptual stages in the process by which top management translate organizational goals into desired actions, namely, belief and practices. Following Jarvenpaa and Ives (1991), we use top management beliefs (TMB) and top management practices to represent two different constructs in our research model (Figure 2).We have grounded our study of top management beliefs (TMB) in the study of Hambrick and Mason (1984). In particular, it is suggested that top managers (executives, upper echelon managers) cope with the complexities of strategic decision making by referring to their pre-existing beliefs about what is appropriate strategic behaviour. These beliefs may also be shaped by their previous experience. This perspective is based on the idea that if we would like to understand particular actions by managers then we must consider "the biases and the biases and dispositions of their most powerful actors—their top executives" (Hambrick, 2007: p. 334). Furthermore, the managers' "experiences affect their (1) field of vision (the directions they look and listen), (2) selective perception (what they actually see and hear), and (3) interpretation (how they attach meaning to what they see and hear) (p. 337).

The TMB represents the psychological state of the top management, while TMP refers to the behavior and actions performed to embrace RMS, that is, top management participation (TMP). Past research shows that TMB is influenced by the external environment. In particular top managers develop "belief structures" to manage concepts and stimuli from the environment and the use of beliefs as a basis for inferences (Walsh, 1988). Furthermore, there is evidence that indicates that TMB guide the desired managerial actions (Walsh, 1988). We therefore can argue that positive beliefs can result in certain managerial actions that can help to embrace RMS within their manufacturing strategies.

Figure 2 around here

Thus,

H1: The stronger the management beliefs about the benefits of RMS are, the higher the level of top management participation is in the implementation of RMS.

Drawing from prior research on RMS (Abdi and Labib, 2003; Garbie, 2013, 2014), we argue that TMP is accomplished by creation of organizational structures that facilitate the implementation of RMS. Firstly, legitimacy is important since RMS systems require changes in organizational structure which may cause resistance from for instance functional departments, trade unions, employee associations. The top manager(s), being the principal(s) will try to implement RMS, but may encounter resistance from the agent(s) who will try to resist because of their own views and agendas and conflicts of interest may arise. Secondly, TMP can instill confidence level among followers especially where the power distance index is higher. Finally, top management can provide adequate resources to embrace RMS. We therefore hypothesize:

H2: The higher the level of top management participation is, the higher the chance is of embracing RMS.

3.2 Organizational Culture, Top Management Participation, and Reconfigurable Manufacturing Systems

The culture of the organization is the byproduct of history, nation culture, product, technology, structure, markets, management styles and types of employee. In the previous sections we looked into the role of culture in influencing top management and advanced manufacturing technologies. We argue that organizational culture moderates the relationship between top management participation and embracing RMS. Thus,

H3: Organizational culture moderates the relationship between the level of top management participation and embracing RMS.

3.3 Reconfigurable manufacturing systems and environmental performance

In the previous sections we highlighted the role of RMS in achieving agility in manufacturing while maintaining waste and cost at a minimum level, and reducing energy through optimization of various manufacturing process (Bi, 2011). Garbie (2013, 2014) further developed a model to assess sustainable development index in manufacturing enterprise in which RMS is important. Speredelozzi and Hu (2002) proposed quality, productivity, convertibility, and scalability as important performance measures, whereas Youssef and El Maraghy (2006) looked into the level of configuration smoothness, conceptualized as expected cost, time, and effort required to convert from one configuration to another system-level configuration. Cost, flexibility, quality, speed, and dependability were considered in the study of Golec and Taskin (2007).

Abdi and Labib (2011) in their model of evaluating performance criteria they used process, cost, quality, efficiency, and risk related to three alternative configurations (layouts). Given that an RMS should be designed for sustainability (Garbie, 2013) and to minimize energy consumption and environmental impacts (Choi and Xirouchakis, 2014), we argue that the more reconfigurable a manufacturing system is, the better it performs through 'reduce', 'reuse' and 'recycle' principles as reconfiguration has an impact on inter alia, waste emissions and energy consumption (Jiang et al., 2012). Therefore we hypothesize:

H4: The higher the re-configurability in manufacturing systems is, the better is the environmental performance.

3.4 Confounding variables

Confounding variables may be referred to as extraneous variables that correlate directly or indirectly with both dependent and independent variable (Vander Weele and Shpitser, 2013). To account for the differences in the organizations, in our study we also include three confounding variables organization / firm size, time and organizational compatibility.

3.4.1 Firm Size

For measuring firm size we adopt the measures used by Liang et al. (2007), that is, number of employees and revenue. The larger the size of the firm, the greater the external pressures on top managers and the greater participation of managers for embracing RMS and achieving environmental performance (Youndt et al., 1996; Ettlie, 1998; Prajogo and Olhager, 2012). We therefore consider the size of the firm as an important confounding variable and by controlling for size of firm, we may draw effective conclusions.

3.4.2 Time

We include the concept of time since organizations have embraced RMS as one of the guiding manufacturing strategies. We view this process as being sensitive to time, and any misalignments that might have occurred in the past would have been resolved at the time the survey took place. We adopted this variable following Liang et al. (2007) and their study on systems' assimilation within organizations.

3.4.3 Compatibility of the organization

We include the concept of compatibility of organizations that denotes the ability of an organization to fit with the RMS. Bunker et al. (2007) argue for the importance of compatibility as an important element in the adoption of IT innovations in organizations. Rogers (1995, p. 224) had defined compatibility as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters." Values are organizational culture's main building block (Quinn and Rohrbaugh, 1983; Khazanchi et al., 2007). They are different from beliefs in that the values are based on organizational culture, whereas beliefs reside within individuals, and stem from experience regarding the appropriate behavior to deal with different events. In this vein, an innovation-supportive culture derives from particular values that "inform an underlying belief structure and reinforce daily practice" (Khazanchi et al., 2007: p. 873). Organizational values may hinder or enable process innovation as well as affecting critical decisions and emerging norms. In our paper, values are therefore influencing how RMT in terms of enabling or hindering it and how it should adopted and integrated within an organization.

Beatty (1998) suggests that value orientation is important, in that an organization can be oriented towards financial results or may take a balanced view that includes financial results but also responsibilities to stakeholders including customers, employees, and society. In this study, the concept of compatibility coincides with 'fit'. Paraphrasing Rogers (1995) and Bunker et al. (2007) we define compatibility of the organization as the ability of the organization to perceive the RMS as consistent with values and beliefs, structures, previously introduced ideas, and needs. This variable has been used in the literature (e.g. Zhu et al., 2012; Zhou and Chong, 2014).

4. Research Design

4.1 Measures

In our research we have used a survey-based technique. A questionnaire was developed using measurements from current literature. Table 1 summarizes the scales for the research model in Figure 2. Measures were adopted or modified from scales identified from literature to avoid scale proliferation. Multi-item measures of constructs were used to improve reliability, reduce measurement error, ensure greater variability among survey individuals, and improve validity (Churchill, 1979). The constructs were operationalized using minimum three items construct and further used confirmatory factor analysis (CFA) (Gerbing and Anderson, 1988).

All items included in the survey were pre-tested to ensure precise operationalization of defined variables in the survey instrument. A pre-test was conducted with 12 academics and business professionals following personal discussions on the proposed questionnaire. Academics belonged to the senior professorial level in the field of OM, SCM and manufacturing management who have established research credentials. Senior business professionals from top management (e.g. head of manufacturing) and senior consultants in manufacturing were consulted. Based on the discussions, questionnaire statements were rephrased accordingly. We did not drop any items from our questionnaire, which was designed in such a manner that questions were understandable and not vague, ambiguous, or difficult to answer (Dillman, 2007).

4.2 Sample and survey description

Different studies have utilized different sampling frames depending upon social and cultural factors (see Liang et al. 2007). Studies utilizing survey methods have exhibited consistency in terms of research design and data gathering processes, and have collected responses from senior managers using mail survey (see Chen and Paulraj, 2004) or by using e-mail survey (see Liang et al. 2007; Eckstein et al. 2015; Dubey et al. 2016), relying on cross-sectional data. The simultaneous collecting of data on exogenous and endogenous constructs may cause 'simultaneity'; that is, causality between independent exogenous constructs and endogenous constructs cannot be definitively determined. Sampling procedures followed clearly seen patterns. Sampling either focused on a narrow setting of one industry (e.g. Dubey et al. 2015a) or broadly covered across industries (e.g. Hitt and Ireland, 1982; Eckstein et al. 2015; Dubey et al. 2016).

We have noted that previous studies have not used data sources of the same content and from same context as in our study, and therefore the collection of primary data is imperative. The survey was administered to managers in Indian manufacturing firms. Specifically, five two-digit National Industrial Classification (NIC) codes were covered in the survey: Division 20 (group 202 related to '*manufacturing of other chemical products*'), division 24 (group 241 related to '*manufacturing of basic iron and steel*'), division 27 (group 279, group 273 and group 271 related to '*manufacturing of electrical equipment*'), division 28 (group 281 and group 282 related to '*manufacturing of heavy machinery*') and division 30 (group 309 related to '*manufacturing of transport equipment*').

We selected 864 potential organizations. We have selected the respondents from following databases: 'Confederation of Indian Industries (CII)', 'Indian Institute of Materials Management', and 'The Chartered Institute of Logistics and Transport (India)'. The title of the specific respondents was sought was primarily vice presidents or director or managers (general, manager, deputy and assistant) of purchasing, logistics, supply chain management and materials management. The respondents were assured that their personal details would not be disclosed. Data was collected using a two-stage approach as suggested by Malhotra and Grover (1998). The data was collected using Dillman's (2007) modified total design test method. The questionnaires were sent randomly to the potential respondents as a copy in an e-mail attachment, and followed up with phone calls. Overall we received 167 out of 864 complete and usable responses after two follow-ups (as shown in Table 2) which represent 19.33 percent response rate. The responses we received are sufficient to test our proposed research hypotheses (Hair et al., 1998), and are comparable to the response rates achieved in recent research investigating operations management topics (e.g. Schoenherr and Mabert, 2008; Braunscheidel and Suresh, 2009; Dubey and Gunasekaran, 2015). The questionnaire was the part of a larger project which runs into 11 pages. The response that we received represents 16.17% vice presidents, 23.95% general managers, 38.92% managers and 20.96% deputy and assistant managers. The encouraging part of the response represents nearly 40%, which belongs to senior cadre (i.e. vice presidents and general managers). Table 2 provides information related to years of experience, types of business activities in which these firms are involved, the age of the firms in terms of years, the revenue generated in the last financial year and the number of employees engaged in these firms. However, the information related to number of employees may be more than shown as there are more than 20% of the workers who are not in the payroll of these respective organizations, mostly daily paid workers.

Table 2 around here

4.3 Non-response bias

The non-response bias test is performed on our collected response to check whether the non-response biasness is not an issue. The non-response bias test was performed on our responses in two waves, the early and late responders (see, Armstrong and Overton, 1977; Chen and Paulraj, 2004). The comparison analysis was based on the t-test, which we performed on these two sets of responses. The test yielded no statistically significant differences (i.e. p=0.1). Here the corresponding value of p=0.1 is found to be greater than p=0.05. Hence, the null hypothesis that states that there is no significant difference between two responses is accepted. Therefore, we concluded that non-response bias is not an issue.

4.4. Assessment of psychometric properties

Before we discuss reliability and validity of our measuring items, it is pertinent to check the assumption of constant variance, existence of outliers, and normality. We used plots of residuals by predicted values, rankits plot of residuals and statistics of skewness and kurtosis. To detect multivariate outliers, we used Mahalanobis distances of predicted variables (Cohen et al., 2003). The maximum absolute value of skewness is found to be less than 2 and the maximum absolute value of kurtosis is found to be less than 5, which is found to be well within the limits (Curranet al., 1996).Cronbach's α value was found to be greater than 0.7 for each construct item, which indicated that the questionnaire was reliable and suitable for further survey.

To ensure that multicollinearity was not a problem, we calculated variance inflation factors (VIF). All the VIFs were less than 4 and therefore considerably lower than the recommended threshold of 10.0 (Hair et al., 1998), suggesting that multicollinearity was not a problem. We used CFA to establish convergent validity and unidimensionality of factors as shown in Tables 3 and 4.

Table 3 around here

From Table 3, we can see that each scale possesses SCR>0.7 & AVE>0.5, above the threshold value suggested for each construct (Hair et al., 1998). The observed value of$\boldsymbol{\lambda}$i > 0.5. The value is more than threshold value of each item that constitutes a construct of framework shown in Figure 1. Therefore, we can assume that convergent validity exists in our framework. We have further derived Pearson's correlation coefficients as shown in Table 4.

Table 4 around here

We compared the squared correlation between two latent constructs to their average variance extracted (AVE) (Fornell and Larcker, 1981). Discriminant validity exists if the squared correlation between each pair of constructs is less than the AVE for each individual construct, further establishing discriminant validity.

The fit indices were as follows for the overall measurement model: Normed Chi-Square=1.679 and Root Mean Square Error of Approximation (RMSEA) =0.072; NNFI=0.912; CFI=0.921. The fit indices met or exceeded the minimum threshold value of 0.09 suggested by Hu and Bentler (1999). After we have performed our validity test and fit indices, we will further use our exploratory factor analysis output as an input for regression analysis.

5. Results - Hypotheses Tests

We tested our research hypotheses using hierarchical regression analysis. This technique was considered most appropriate rather than covariance-based modeling approaches, due to the complexity of the model and available data points, as well as due to the robustness of the technique (Gefen et al., 2000). We have presented our four hypotheses in Table 5.

Table 5 around here

From Table 5 we can infer that our all four research hypotheses are supported. In case of hypothesis H3, the VIF statistic is more than cut off value due to moderation effect.

6. Discussion

6.1 Theoretical Implications

We set out to explore the role of top management beliefs and participation in environmental performance, as mediated by RMS and moderated by organizational culture. Our results show that management beliefs about the potential benefits of RMS motivate top managers to actively participate as principals in the processes that relate to RMS adoption in order to achieve environmental performance, but, it may be that conflicts of interest may arise since other parties (agents) that aim at embracing RMS may have different views and agendas. This study suggests that the higher top management participation is, the higher chances RMS has of being adopted as the manufacturing strategy of an organization. These results extend prior research on RMS design (Abdi and Labib, 2003; Bi et al., 2008; Garbie, 2013, 2014) and those studies (Yen and Yen, 2012; Abdulrahman et al., 2014; Jabbour and Jabbour, 2016) underlining the role of senior management beliefs and practices in adopting sustainable practices. However, these studies do not focus on environmental performance. Our study illustrates that there is a link between top management commitment and environmental performance (Aragon-Correa et al., 2008; Boiral et al., 2009; Shaukat et al., 2015) by considering the impact of top management beliefs and participation in RMS.

We extend the literature on Agency Theory (Eisenhardt, 1989). We conceptualize top managers as principals who translate organizational goals into desired actions. The actions relate to the adoption of RMS and the achievement of environmental performance (Abdi and Labib, 2003). We are not using, Agency Theory to understand risks and relationships (Halldorsson and Skjott-Larsen, 2006), but we extend the application of Agency Theory to highlight the role of managers and the 'translation' of their beliefs and participation in achieving performance. Our use of both Agency Theory and organizational culture coincides with the views of scholars (e.g. Qu et al., 2015; Shaukat et al., 2015) who suggest that top managers are influenced both by uncertainty (Paille et al., 2014), but (as in our case) by organizational culture. We reinforce, therefore, the argument that when managers act as principal agents they translate their commitment and participation (influenced by culture) to environmental performance (Boiral et al., 2009; Paille et al., 2014; Shaukat et al., 2015). At the same time, our study differs from the aforementioned in that we are not investigating the relationship between HRM or CSR strategies and performance (Paille et al., 2014; Shaukat et al., 2015), but the impact of the managerial agency through management commitment and participation on RMS adoption and subsequently on environmental performance.

Our results suggest that organizational culture (Hofstede et al., 1990, Smircich, 1983; Bates et al., 1995) moderates the relationship between the level of top management participation and RMS adoption. We, hence, address the literature gap highlighted by Khanchanapong et al., (2014) to further study the role of culture in the adoption manufacturing technologies for performance, focusing on RMS and environmental performance. Furthermore, by focusing on the role of organizational culture in RMS, we extend those studies focusing on culture, structure, and technology adoption (Zammuto and O'Connor, 1992; McDermott and Stock, 1999; Leidner and Kayworth, 2006), as well as those focusing on the role of culture on various supply chain and OM phenomena (Gunasekaran and Spalanzani, 2012; Pampanelli et al., 2013; Kurdve et al., 2014).

Our study extends the literature on the role of RMS in achieving agility. We coincide with the view of Bi (2011) that agility is related to maintaining waste and cost at minimum levels. We also suggest, however, that the minimization of cost and waste can assist in achieving environmental performance. This finding extends studies focusing on sustainable development and RMS (Garbie, 2013; 2014). Our results fully support the hypothesis that the higher the adoption of reconfigurable manufacturing systems –that is, the higher the re-configurability of the manufacturing systems within an organization -the higher their environmental performance is.

Finally, our study investigates the link between top management participation and beliefs and RMS adoption and the impact of the latter on environmental performance focusing on developing countries and in particular on the Indian context. Our study, hence is in line with the endorsement of scholars (e.g. Sarkis et al., 2011; Govindan et al., 2014; Muduli et al., 2014) to further study green and environmental practices in developing countries, and therefore environmental performance.

Therefore, to our knowledge, this is the first attempt to empirically test the impact of RMS on environmental performance. Furthermore, our study is perhaps the first attempt to develop an integrated model that extends the behavioral operations management literature in relation to environmental studies. Our study, therefore, addresses the suggestions of scholars to study behavioral aspects of OM and SCM and related technologies (Gino and Pisano, 2008; Croson et al., 2013) using alternative methods (Taylor and Taylor, 2009).

6.2 Managerial Implications

Our findings offer guidance to manufacturing managers and industrial engineers. The mediating role of RMS clearly indicates that top management involvement and cleaner production can be achieved through reconfigurable manufacturing which is relatively cheaper in comparison to those of flexible manufacturing systems. Our findings suggest that positive organizational culture has a moderating effect on RMS and can assist in achieving competitive advantage. We acknowledge that recommending organizations to actively align their RMS strategies with their organizational culture may be generic. Presumably, it is in the best interest for these organizations to completely embrace RMS. From this perspective, we view that proper alignment between top management participation, RMS, and organizational culture can offer benefits to those organizations that are pursuing environmental performance aiming to achieve cleaner production or green production goals.

6.3 Limitations of the study

Our present study has its own limitations. Our study focuses on manufacturing firms, and it may be that if we had tested the model using data from other industries, the results may have been different. Moreover, the data collection phase occurred at one point of time. It may be that causal analyses cannot be ascertained without longitudinal data. Furthermore, in our model we have not considered social dimensions as well as economic criteria, which may be very important for sustainable business development. Moreover, we have used subjective measurements (self-assessment) in our questionnaire, although they have been adopted from previous studies. Finally, we have not considered institutional pressures, which can provide an alternative perspective to analyze the vested interest of the organizations behind these programs.

7. Conclusion

The RMS in recent years has been found to be a useful manufacturing strategy. However, there is scant literature that has attempted to empirically test the possible impact of RMS on environmental performance and in particular with regards to the role of top management and organizational culture in the successful implementation of RMS. To address these gaps, we developed an integrated model, which has hypothesized the relationship between agency theory, organizational culture and RMS (Figure 2). The analyses based on 167 responses support the hypothesized relationships in the framework. In the following section we have outlined future research directions.

7.1 Future research directions

Notwithstanding the limitations of our research, the study can be extended to include other manufacturing strategies and empirically investigate how each manufacturing strategy can complement others in different conditions. Additionally, our study can be enhanced by using samples from other industries and firm sizes, or longitudinal data to establish causal relationship among antecedents and dependent variables, or using multiple cases to further investigate the role of top management participation and the role of RMS and organizational culture. The possible association among environment, social and economic benefits can further be explored, as well as the inclusion of constructs such as environmental attitude, vision, and environmental guidelines. Although our study is among the first to combine organizational culture and Agency Theory to study the role of top management beliefs and participation in environmental performance, we would encourage its further application to provide insights into the behaviour of top managers for the triple bottom-line of sustainability. Future studies could extend the study of organizational culture to look at national culture and its impact on top management beliefs and participation on environmental, and sustainability performance. Finally, given contemporary conditions as well as considering the environment tendencies as a whole, manufacturing systems models could be studied by focusing on "Environmental Performance" as their ultimate goal; in this vein, new measures on Environmental Performance may be required.

We hope that this study will offer an alternative lens to those who study the impact of top management beliefs and participation on environmental performance, RMS, and the role of culture in this process.

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Table 1: Building blocks of the theoretical model and their elements

Scale	Reference	Questions
Top management beliefs	Walsh (1988); Jarvenpaa and Ives (1991)	• RMS has the potential to provide significant benefits to the firm in uncertain environment; • RMS will provide competitive edge to the firms; • RMS is one of the alternative manufacturing strategies for the firm;
Top management participation	Chatterjee et al., (2002)	• The senior management of our firm actively articulates the vision for the use of RMS; • The senior management actively formulated a strategy for the successful implementation of RMS; • The senior management established a goals and standards to monitor the RMS;
Organisational culture	Yiing and Ahmad (2009)	• Mutual respect among team members; • Sharing of information among team members; • Willingness to accept change in the organizational structure; • Willingness to deal with customer queries in time; • Involve partners of the organization in the decision making process; • Respect for national culture.
Reconfigurable Manufacturing Systems	Bi (2011);Garbie (2013,2014)	• System Size • System Functionality • Material Handling Equipment • Material Handling Storage System • Identification System • Location • Plant Layout
Environmental performance	Carter and Rogers (2008);Azevedo et al., (2011);Deif (2011); Bhateja et al., (2012)	• Environmental technology • Recycling efficiency • Eco packaging • Level of process management that includes pollution control, waste emissions, carbon footprints.

Table 2: Demographic profiles of the respondents

		Number of respondents	Percentage of respondents
Designation	Vice President	27	16.17
	General Managers	40	23.95
	Managers	65	38.92
	Deputy/Assistant Managers	35	20.96
Job experience (years)	Above 20	53	43.00
	15-20	50	28.45
	10-14	29	16.26
	5-9	25	8.13
	0-4	10	4.07
Nature of business activities	Auto Components manufacturing firms	45	26.95
	Heavy Machinery	45	26.95
	Electrical Components	37	22.16
	Steel Sector	23	13.77
	Chemical	17	10.17
Age of the firm	>20	45	26.95
	15-20	77	46.11
	10-14	27	16.17
	5-9	18	10.77
	1-4	0	0
Annual Revenue	> 2000 crores (INR)	18	6.50
	1500-2000 crores (INR)	42	14.63
	1000-1499 crores (INR)	25	16.26
	500-999 crores (INR)	27	21.95
	< 500	55	40.65
Number of employees in the payroll	Greater than 500	67	16.26
	250-500	29	26.02
	100-249	40	32.52
	Less than 100	31	25.20

Table 3: Constructs and their items (factor loadings, error, AVE)

Construct	Items	λi	SCR*	AVE
Top management beliefs(TMB) Cronbach's Alpha: 0.947 (X1)	RMS has the potential to provide significant benefits to the firm in uncertain environment	0.832	0.85	0.66
	RMS will provide competitive edge to the firms	0.784		
	RMS is one of the alternative manufacturing strategies for the firm	0.818		
Top management participation (TMP) Cronbach's Alpha: 0.885 (X2)	The senior management of our firm actively articulates the vision for the use of RMS	0.805	0.86	0.67
	The senior management actively formulated a strategy for the successful implementation of RMS	0.818		
	The senior management established a goals and standards to monitor the RMS	0.827		
Organisational culture Cronbach's Alpha: 0.960 (X3)	Mutual respect among team members	0.814	0.92	0.67
	Sharing of information among team members	0.782		
	Willingness to accept change in the organisational structure	0.817		
	Willingness to deal customer queries in time	0.837		
	Involve partners of the organisation in the decision making process	0.818		
	Respect for nation culture	0.832		
Reconfigurable Manufacturing Systems Cronbach's Alpha: 0.912 (X4)	System Size	0.881	0.92	0.63
	System Functionality	0.781		
	Material Handling Equipment	0.793		
	Material Handling Storage System	0.863		
	Identification System	0.765		
	Location	0.732		
	Plant Layout	0.712		

Environmental Performance Cronbach's Alpha: 0.881 (Y1)	Environmental technology	0.880	0.87	0.63
	Recycling efficiency	0.823		
	Eco packaging	0.875		
	Level of process management which includes pollution control, waste emissions, carbon footprints etc.	0.541		

**Here SCR (Scale Composite Reliability)= (∑𝝀i)2/((∑𝝀i)2+ (∑ei))*

Where 𝝀i= standard loadings of i-th item;

ei= 1- ((∑𝝀i)2) which represents the measurement error in i-th item

Table 4: Pearson's correlation coefficients

	X1	X2	X3	X4	Y1
X1	0.810[a]				
X2	0.130	0.820[a]			
X3	0.009	0.311**	0.820[a]		
X4	0.008	0.277**	0.429**	0.790[a]	
Y1	0.190	0.321	0.327**	0.061	0.790[a]

*Significant at $p<0.05$

**Significant at $p<0.01$

a. The square root of the construct's AVE is provided along the diagonal

Table 5: Regression Analysis Output

Hypothesis	R^2	F	β coefficient	p
H1	0.660	334.594	0.755	0.000
H2	0.462	147.808	0.609	0.000
H3	0.527	193.862	0.574	0.000
H4	0.654	325.295	0.783	0.000

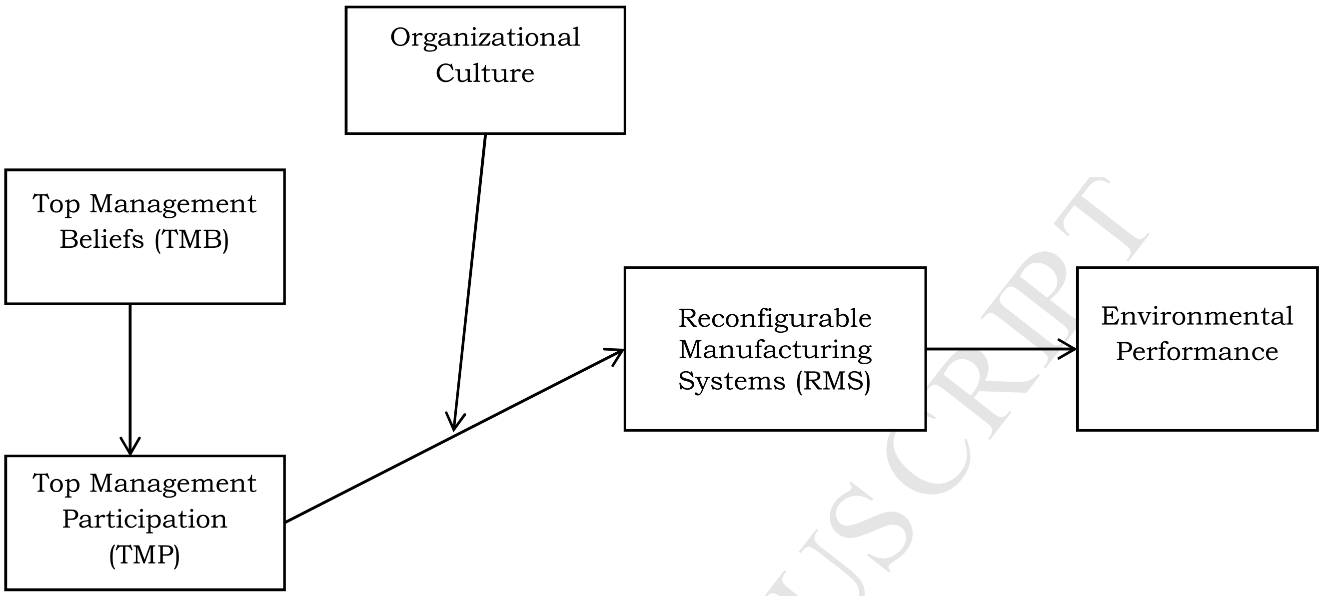

Figure 1: Theoretical Framework

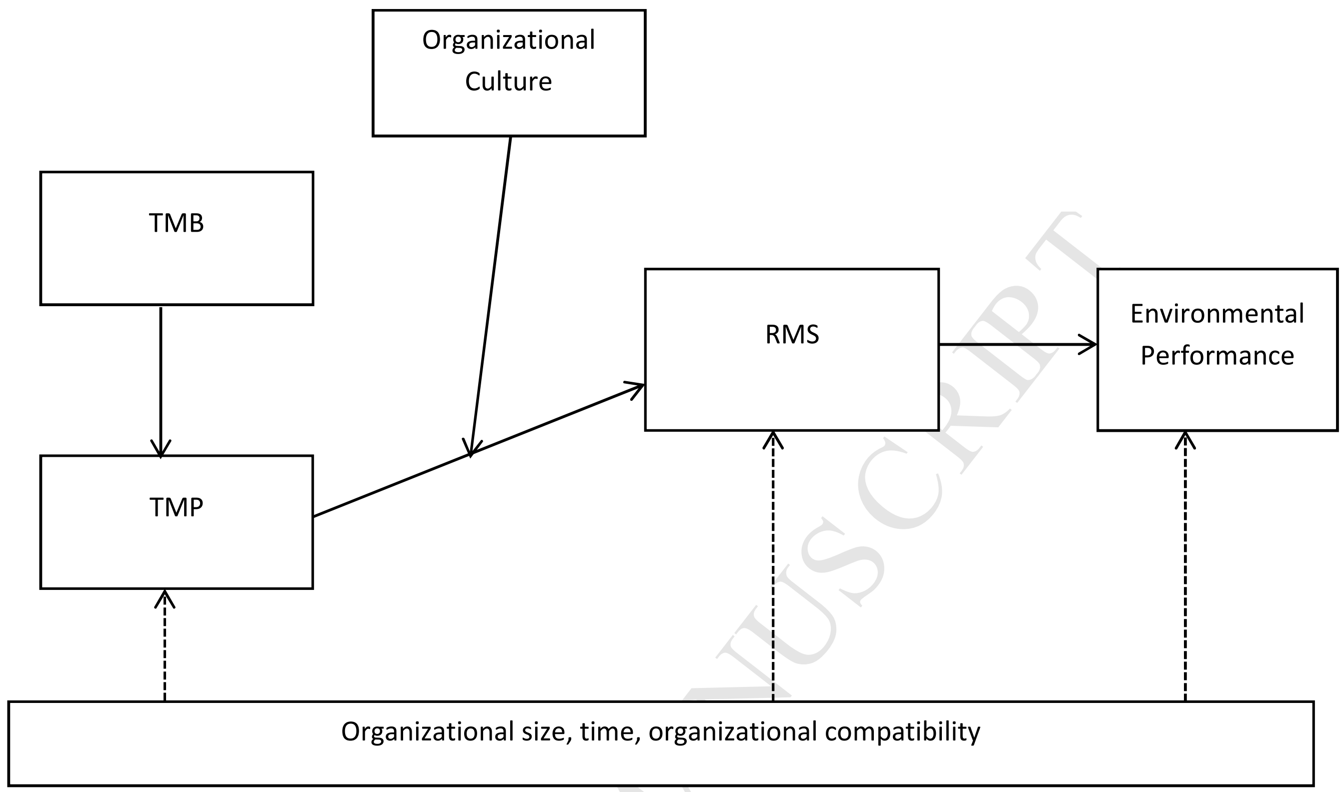

Figure 2: Research model

Highlights:

- Applies agency theory on reconfigurable manufacturing systems (RMS)
- Draws on organizational culture to study RMS
- Links RMS, top management beliefs, participation, and environmental performance
- High top management beliefs and participation bring high RMS adoption and performance
- Culture moderates the link between beliefs and participation, and performance