DEPLOYING AMBIDEXTERITY THROUGH BETTER MANAGEMENT PRACTICES: AN INVESTIGATION BASED ON HIGH-VARIETY, LOW-VOLUME MANUFACTURING

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Abstract

Purpose:

While capabilities in exploiting existing assets and simultaneously exploring new growth opportunities have proven essential components in competition, an understanding of how organisations deploy these so-called ambidextrous capabilities remains elusive. Thus, we aim to investigate the role of better management practices (BMP), as organisational routines, in deploying ambidextrous capabilities in practice.

Design/methodology/approach:

High-Variety, Low-Volume (HVLV) manufacturers are adopted as exemplar ambidextrous organisations. A conceptual model was developed where BMP, by way of human resource management (HRM) and production planning and control (PPC), are considered mediators in the relationship between ambidextrous capabilities and organisational performance outcomes. Partial least squares structural equation modelling was adopted to analyse the survey undertaken in Australia.

Findings:

The results suggest that merely holding ambidextrous capabilities is not enough – demonstrating a fully mediating role of BMP between ambidextrous capabilities and HVLV manufacturer performance outcomes. However, the individual effects of PPC and HRM prove varied in their unique impact on HVLV manufacturer performance.

Originality:

By exemplifying the explanatory power of BMP in ambidextrous capability deployment, this study moves beyond the more prevalent stance on the links between BMP and ambidextrous capabilities as that of capability building *through* management practices, to one concerning the deployment of the capability itself.

Practical implications:

This study also provides a rare account of how HVLV manufacturers can leverage their inherently ambidextrous design towards greater organisational performance and demonstrate critical considerations in selecting organisational capabilities.

Key Words: Ambidexterity, Better Management Practices, High-Variety, Low-Volume Manufacturing

1 Introduction

Organisations' ability to exploit existing resources towards efficiency improvements has become an increasingly pervasive area of concern for operations scholars and practitioners (Andriopoulos et al. 2018). While extant literature suggests that organisations holding these so-called ambidextrous capabilities observe greater organisational performance (Junni et al. 2013), the question of how this happens remains a strongly contested (Wu et al. 2020, Felício et al. 2019) and ambiguous (Andriopoulos et al. 2018, Benner and Tushman 2015) phenomenon.

We aim to key into this conversation by conceptualising ambidexterity as a dynamic capability (DC) (D'Souza et al. 2017, O'Reilly and Tushman 2008). Taking cues from DC theory (Eisenhardt and Martin 2000, Winter 2003), we build on this understanding of ambidextrous capabilities and introduce the notion of better management practices (BMP) as a potential conduit from which ambidextrous capabilities can impact organisational performance outcomes.

In adopting the case of high-variety, low-volume (HVLV) manufacturers as exemplar ambidextrous organisations, our survey data suggests that merely holding ambidextrous capabilities is not enough. Instead, we find that BMP – consisting of production planning and control (PPC) and human resource management (HRM) practices – fully mediate the relationship between ambidextrous capabilities and organisational performance outcomes. We follow the call for more research into the role of management practices in leveraging ambidextrous capabilities in practice (Wu et al. 2020, Birkinshaw and Gupta 2013) and the relationship between ambidextrous capabilities and lower-order routines (Zimmermann and Birkinshaw 2016). We provide evidence to support the changing role of lower order routines in supporting DC in impacting organisational performance outcomes (Schriber and Löwstedt 2020, Waleczek et al. 2019, Protogerou et al. 2011). By considering BMP as a mediating factor, we also flip the discussion from how ambidextrous capabilities can help facilitate the link between BMP and organisational performance outcomes to one concerning the deployment of the capability itself. In doing so, we find that while organisations can certainly build ambidextrous capabilities, it does not necessarily equate to better performance outcomes.

The paper has five sections. Section 2 provides an overview of the theoretical basis leading to our conceptual model in the context of HVLV manufacturing. Section 3 articulates the research methodology, while Section 4 illustrates the results of this research. Finally, Section 5 provides a discussion and conclusion involving implications to both theory and practice and outlining the limitations and potential areas for further research.

2 Ambidexterity, Better Management Practices, and HVLV Manufacturer Performance

2.1 Ambidexterity as a Dynamic Capability: The Role of Management Practices

In general, an organisations' capacity to realise benefits from the seemingly contradictory tensions of exploration and exploitation appears driven by their ability to formulate a viable strategic trajectory (c.f. Pisano 2017). Thus, ambidexterity is not necessarily a source of competitive advantage in itself; it is the resource reconfigurations stemming from this capability that seems to facilitate this (O'Reilly and Tushman 2008).

Such a conceptualisation holds important implications for the understanding of how ambidexterity is achieved in practice. Keeping with the understanding of capabilities as "high-level routine[s]… that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type" (Winter 2003, p. 991), we would assume 1) ambidextrous capabilities exist on a higher-level than routines (i.e., is formed by lower-level routines); 2) routines are not the only "inputs" – competencies also draw on skill, knowledge and governance mechanisms (Teece 2007) and; 3) ambidexterity is a managerial construct involving actual decision-making and is hence not purely a function of environment or context (Birkinshaw and Gupta 2013). Thus, ambidextrous capabilities can be characterised as a function of "lower-level" routines that, together with other "inputs," including structure and governance mechanisms, enable an organisation to explore and exploit through effective leadership. What this also suggests, however, is that holding ambidextrous capabilities and deploying them may be two different phenomena (Wilden et al. 2016).

Simultaneously leveraging exploitation and exploration is no easy feat. Both activities require fundamentally different structures, processes, and cultures to function (O'Reilly and Tushman 2008). These activities often become self-reinforcing as well (March 1991). The same goes for organisations competing based on both exploration and exploitation simultaneously, i.e., when significant strategic direction changes occur. Thus, a change is necessary to this balance; the organisation stagnates (Luger et al. 2018). Indeed, there are marked differences in firms' performance that can leverage ambidexterity (Birkinshaw and Gupta 2013, Junni et al. 2013, O'Reilly and Tushman 2013, Pisano 2017, Wu et al. 2020).

The fact that operational processes impact ambidextrous capability deployment is not an entirely new development. Operations scholars have grappled with this problem in the guise of the productivity dilemma for some time, have long warned about the interactions between operational

routines and their impact on exploitation and exploration (Adler et al. 2009, Benner and Tushman 2003). More recent work has also begun to investigate this impact, bringing forth a nuanced understanding of this relationship (Matthews et al. 2015). Tamayo-Torres et al. (2017) argued that ambidextrous capabilities could help facilitate manufacturing improvements in quality, delivery, cost, and flexibility via the sand cone model. This work suggests that ambidextrous capabilities may be conducive to the simultaneous adoption of seemingly incompatible management practices.

The theoretical support for these arguments also appears to stem from similarities between process improvement initiatives and DC, citing that they may be the same (Anand et al. 2009, Eisenhardt and Martin 2000). In this case, leveraging DC involves explicit attention towards creating a sufficient foundation that includes standardised management practices. Which practices are adopted, and how they are adopted involves a skill level that shows how an organisation can leverage its capabilities to any practical effect (Teece 2017). Complementarities between management practices also play a crucial role in leveraging conflicting organisational demands in exploitation and exploration (MacDuffie 1995). These management practices once characterised as ordinary, zero-order, or operational capabilities (Helfat and Winter 2011) have emerged as just as necessary in achieving competitive parity by continuous organisational adaptation in exploratory and exploitative goals as higher order DC (Schriber and Löwstedt 2020).

Despite these significant attempts to realise the role of management practices in making ambidextrous capabilities work, there remains ambiguity in uncovering how their interactions influence organisational performance outcomes. Despite this question being raised by Anand et al. (2009) in the role of management practices in helping to make use of ambidextrous capabilities, also partially addressed by Matthews et al. (2015), the organisational outcomes of their interactions, particularly the deployment of the capability through routines (Zimmermann and Birkinshaw 2016), leave much to be desired.

2.2 The Case of HVLV Manufacturing and Better Management Practices

HVLV manufacturers are typically characterised as small to medium sized enterprises (SME's) that produce a high variety of products at low volumes (Katic and Agarwal 2018). In terms of manufacturing strategy, they can present themselves as both make-to-order or engineer-to-order organisations, depending on where the customer order infiltrates the manufacturing value chain (Katic and Agarwal 2018).

The project-based nature of their manufacturing strategy means uncertainty impacts operations from both the external environment (from the types of products produced) as well as internal to the firm (from the manufacture of the goods themselves) (Stevenson et al. 2005). Intuitively, a core competency in HVLV manufacturing is in effectively navigating through the variations in customer demand and product specifications towards completing the job within time and budget goals (Adrodegari et al. 2015). Thus, it is not uncommon to see the job-shop style of production being adopted with flexibility in processes, machinery, and personnel proving essential to retaining a viable organisation and meeting the requirements of requisite variety (Amaro et al. 1999). However, to operate faster, better, and cheaper than their competitors, the HVLV manufacturer must be able to break-free from operational norms towards leveraging their internal capabilities to meet disparate customer needs (Katic and Agarwal 2018). That is to say; the HVLV manufacturer must be able to harness the knowledge and skill encapsulated in operational routines towards improving their ability to undertake project-based work and simultaneously be responsive to changing customer requirements. HVLV manufacturers need to be ambidextrous if they survive in the long-term, making such firms an exemplar case for this study's purposes.

On the other hand, BMP presents themselves as routinised patterns of behaviour that appear better than others in achieving greater organisational performance outcomes. Stemming from the best-practice tradition in manufacturing strategy literature (Voss 1995), BMP has (re)emerged as a significant factor explaining major differences in productivity between firms (Agarwal et al. 2014) as well as entire economies (Bloom and Van Reenen 2006). Some researchers establish a competitive advantage theory based on the BMP concept (Bromiley and Rau 2014).

The logic behind BMP closely resembles best-practice research in operations management to select exemplar practices across multiple contexts (Voss 1995). The fact they appear as observable and measurable artefacts (Bloom and Van Reenen 2006) has not only aided in their popularity amongst scholars, but it also seems to portray qualities that can then be easily transferred amongst different organisations. However, the BMP adoption is, in itself, a skill that requires substantial effort upon implementation (Bloom et al. 2018).

We pursue the notion of BMP in this study because of their perceived role as one of the building blocks for DC (Teece 2017). BMP characterise "stability" and exploitative tendencies in organisations (Benner and Tushman 2003), as well as they propel innovation and aid exploration (Agarwal et al. 2014),.

2.3 Ambidextrous Capabilities, Better Management Practices and HVLV Manufacturer Performance

Given the objective to investigate the role of routines (by virtue of BMP) in the link between ambidexterity and organisational performance outcomes, the research model in Figure 1 was developed.

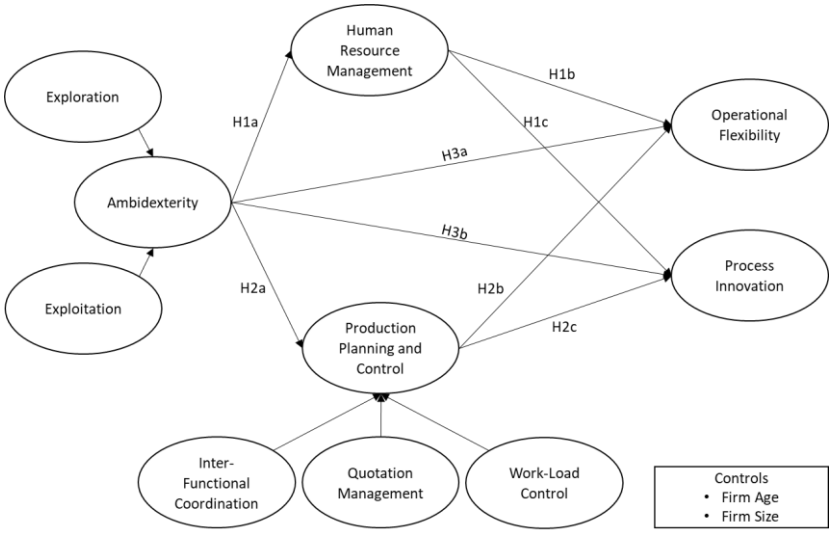

Figure 1 Research Model

Provided the HVLV manufacturing context, the dependant variables representing organisational performance outcomes are related to their core competencies in producing a wide variety of customised products (operational flexibility) and doing this well (process innovation). Human resource management and production planning and control were selected as BMP to reflect their underlying significance in HVLV manufacturing literature, particularly their prevalence in studies concerning best-practice in such a context (Petroni et al. 2017).

Firm age and firm size were selected as controls due to their known impacts on BMP adoption (Agarwal et al. 2014) in the case of the latter and the peculiarities associated with flexibility, legitimacy, and resource constraints (Carayannopoulos 2017) in the case of the former.

Human Resource Management Practices

HRM is a known driver enabling ambidextrous capabilities (Úbeda-García et al. 2018). In this case, however, we are not necessarily concerned with fostering or building ambidextrous capabilities, rather in deploying these capabilities themselves. Thus, it is essential to recognise ambidextrous firms also require "ambidextrous" people (Miron-Spektor et al. 2017). In this respect, HRM practices, including employee training and job-security, are said to improve an employees' ability, motivation, and opportunity to perform (Jiang et al. 2012). Ambidexterity has also been associated with the complimentary adoption of both performance management practices and those which create an adequate social context (Birkinshaw and Gibson 2004) – also forming a key part of BMP literature in general (Bloom and Van Reenen 2006). Knowing individual motivation, know-how, skill, experience, and attitude are also drivers of translating capabilities into routines and routines into organisational outcomes (Abell et al. 2008); we construct the following hypotheses:

H1a: Ambidexterity is positively associated with the adoption of HRM practices

Along the same vein, workers in HVLV manufacturers are renowned for their flexibility in terms of dealing with the dynamism associated with the HVLV manufacturing strategy (Birkie et al. 2017). Traditionally speaking, they observe quite some pride in their ability to problem solve and ultimately "get the job done"(Clegg and Fitter 1981). HRM practices are an essential component in leveraging these talents towards world-class standards (Muda and Hendry 2003). Indeed, for the HVLV manufacturer, HRM practices present one of the more significant competitiveness areas in operational flexibility and process innovation performance (Petroni et al. 2017). Thus:

H1b: HRM practices are positively associated with HVLV manufacturer operational flexibility

H1c: HRM practices are positively associated with HVLV manufacturer process innovation performance

Production Planning and Control Management Practices

Effective production planning and control (PPC) has long been of concern for ambidextrous organisations such as HVLV manufacturers (Aslan et al. 2015, Stevenson et al. 2005). The use of PPC has been associated with greater performance by setting appropriate costs and lead-times towards increased competitiveness and navigating the uncertain environment in which they typically reside (Zennaro et al. 2019). Greater flexibility to deal with the influx of disparate orders presents itself as a by-product of effective PPC adoption (Katic and Agarwal 2018). Also, while more intuitive PPC

approaches seem appropriate when business is slow when the order-book begins to rise, those HVLV manufacturers with effective PPC practices exhibit increased decentralisation levels and less myopic managerial decision making (Stevenson and Vanharanta 2015). This behavior has also been observed to help organisations leverage the contradictory demands of exploitation and exploration towards greater performance outcomes (Jansen et al. 2012). By taking on formal PPC practices, the top management team is "free" to perform more strategic and long-term decision-making. As Petroni et al. (2017) also assert, effective PPC is a form of innovation for HVLV manufacturers. Taking into consideration PPC forms a central component of both reactive flexibility and proactive flexibility, which effective HVLV manufacturers are suggested to hold (Katic and Agarwal 2018), we hypothesise the following:

H2a: Ambidexterity is positively associated with the adoption of PPC practices

H2b: PPC practices are positively associated with HVLV manufacturer operational flexibility

H2c: PPC practices are positively associated with HVLV manufacturer process innovation performance

The Mediating Role of Better Management Practices Between Ambidextrous Capabilities and HVLV Manufacturer Performance Outcomes

According to previous discussions, the inability to leverage ambidextrous capabilities towards organisational performance outcomes is a function of the relationship between organisational capabilities, routines, and performance outcomes. We suggest that ambidextrous capabilities are not enough to directly influence organisational performance as their capabilities rely on a synthesis between competing objectives by adopting routines (Helfat and Winter 2011). As per the capabilities-based view, it is the configurations of routines that drive performance outcomes, not necessarily their capabilities (Protogerou et al. 2011). Hence, we propose the following hypotheses:

H3a: *PPC management practices mediate the relationship between ambidextrous capabilities and HVLV manufacturer performance outcomes.*

H3b: *HRM management practices mediate the relationship between ambidextrous capabilities and HVLV manufacturer performance outcomes.*

3 Research Methodology

3.1 Development of Measures

In developing the measures for constructs used in this research, we adopt the guidelines set-forth by Forza (2016) that involve articulating an operational definition of the construct, followed by assessing its content validity. Thus, the more established constructs of ambidexterity, process innovation, and operational flexibility were adapted to suit the study's objectives, while HRM and PPC management practices underwent a quantitative assessment of content validity using the content validity index (CVI).

The following outlines the development of each measure according to the type of content validity assessment undertaken.

Ambidexterity

Ambidexterity is defined as a DC, enabling the simultaneous pursuit of exploratory and exploitative activities. This DC becomes a maximising exercise where both exploration and exploitation's combinatory power results in greater organisational performance (Cao et al. 2009).

In taking the capabilities-based view of ambidexterity, and in line with D'Souza et al. (2017), we recognise that exploration and exploitation are two fundamentally distinct activities. Even though they are both required in achieving ambidexterity, they also impact organisational performance differently (Benner and Tushman 2015). Routines form exploratory and exploitative activities unique in their inputs, structure, and processes (O'Reilly and Tushman 2008). Thus, ambidexterity is a second-order reflective-formative construct consisting of exploratory and exploitative activities (Pertusa-Ortega and Molina-Azorín 2018). In our case, the measures for the first order reflective constructs of exploration and exploitation are adapted from a five-point Likert scale developed by Lubatkin et al. (2006).

Because content validity is a major concern for formative second-order constructs (Ringle et al. 2012), we conducted an expert workshop consisting of four academics with a keen understanding of organisational ambidexterity and HVLV manufacturing to assess this.

During the workshop, questions were raised over the efficacy of two measures relating to creating products and services and increasing automation in operations. It was concluded that HVLV manufacturing's nature renders new products/services limited in applicability. Along the same line, automation is of limited relevance in an HVLV manufacturing environment where predictive engineering techniques or pre-production activities are primarily applicable at higher levels of

predictability (Haug et al. 2009). Given this, we removed these constructs from the survey. A final list of measures for the constructs of exploration and exploitation is shown in Appendix A.

Operational Flexibility

Operational flexibility refers to the ability of HVLV manufacturers to produce a wide range of products. It has a rich theoretical underpinning in manufacturing strategy literature (Netland and Frick 2017) and literature akin to HVLV manufacturers (Tamayo-Torres et al. 2017). Nonetheless, in this paper, we have opted to adopt the measures for operational (process) flexibility by Swink et al. (2005) given their relevance to the HVLV manufacturing environment.

Process Innovation

Process innovation means "new or significantly improved production or delivery methods [including] significant changes in techniques, equipment and software" (OECD and Communities 2005). As such, we adopt the measures for process innovation by Prajogo and Sohal (2003) that have focused on assessing the impact of management practices on organisational outcomes and their relevance for this study.

Quantitative Approach to Content Validity for Human Resource Management and Production Planning and Control

Since PPC and HRM (as BMP) have seen little empirical testing in the context of HVLV manufacturing, measures for these constructs were developed and tested before use in the final survey.

To accomplish this, we adopt the content validity index (Polit and Beck 2006, Forza 2016) whereby a group of experts assesses the degree to which a particular item helps explain the construct it is trying to measure (Polit and Beck 2006). A five-point Likert scale was used to evaluate their responses, ranging from not important (1) to very important (5). An "unsure" option was included in the instance where the subject matter expert was not familiar with a certain construct, in which case we could then remove this from the sample. In all, 13 subject matter experts participated, well above the minimum requirement of three (Lynn 1986).

Next, an evaluation of CVI requires two separate calculations at the individual item level (I-CVI) and at the entire scale level (S-CVI) (Lynn 1986). To calculate the I-CVI, we first code those responses that ranged from important (4) to very important (5) as an indicator of relevancy. Then, we calculate the I-CVI by dividing the number of subject matter experts that responded with a 4 or 5 by the total number of experts. To address the probability of chance occurrence (P_c) inflating the CVI values, we adopt a modified Kappa statistic (K) used by Zamanzadeh et al. (2015). The content validity at the

scale level is then calculated, where S-CVI is found by averaging the item level CVI's (Polit and Beck 2006). The equations adopted for P_c and K are shown below, where N is the number of subject matter experts in the panel, and A represents the number of subject matter experts that agree the item is important (thus, responding with a 4 or a 5).

$$P_c = \left[\frac{N!}{A!\,(N-A)!}\right] * 0.5^N$$

$$K = (ICVI - P_c)/(1 - P_c)$$

Values of K above 0.74 can be considered excellent, while values between 0.6-0.74 can be considered acceptable, and values of 0.4-0.59 can be considered fair (Zamanzadeh et al. 2015).

Production Planning and Control

Initially, PPC consisted of two separate activities in sales and workload control. Because they are essential in explaining PPC overall and present themselves as two different sets of management practices, the initial thought was constructing a second-order reflective-formative construct. Based on this, we proposed the following measures (shown in Table 1).

Table 1. Initial Measures for Sales and PPC derived from Literature

Code	Description of Measures (PPC)	Key References
PPC1	We implement a systematic method of workload control	Hendry et al. (2013)
PPC2	We employ a pre-shop floor pooling and release system to improve flow in manufacturing operations	Thurer et al. (2012)
PPC3	We have a systematic method of bottleneck detection and reduction	Petroni et al. (2017)
PPC4	Job priorities are clearly understood by everyone on the shop floor	Muda and Hendry (2003)
PPC5	We rigorously pursue quick change over and set-up times for our machines and strive to improve them	Muda and Hendry (2003), Petroni et al. (2017)
PPC6	We structure our manufacturing practices and shop-floor layout based on the identification of common product families	Petroni et al. (2017)
Sales1	We keep track of and monitor all quotation (both won and lost) in an easy access database	Muda and Hendry (2003)
Sales2	We have a keen understanding of our competitors and employ a systematic quotation control system in order to help guide cost and lead time estimations for customer enquiries (for example, a strike-rate matrix)	Muda and Hendry (2003)
Sales3	We actively help customers meet their goals rather than just providing customers' wants	Muda and Hendry (2003)
Sales4	There is a high degree of coordination between all departments to ensure we set realistic due dates for customer enquiries	Zorzini et al. (2008)
Sales5	Capacity and resource availability information is readily available to both manufacturing and sales departments when responding to customer enquiries	Kingsman et al. (1996)
Sales6	There is a high degree of coordination between our organisation and our suppliers when we respond to customer enquiries	Zorzini et al. (2008)

These measures were then used in a content validity test based on the CVI (See Appendix B). There is relative convergence amongst the subject matter experts in understanding the items to their respective constructs. However, a cross-validation exercise involving a post-hoc literature review prompted by comments from the study participants revealed a discrepancy concerning items PPC5 and PPC6.

Quick change-over and setup times seem valid for machining and tooling HVLV manufacturers, though appeared less relevant for those in heavy fabrication. Similarly, the restructure of the shopfloor to suit common product families does not appear relevant in versatile manufacturing companies where repeat business is often not possible. For these reasons, PPC5 and PPC6 were removed. PPC2 can also be considered a subset of PPC1. To avoid confusion, and for the sake of simplification, PPC2 was also removed, leaving PPC1, PPC3, and PPC4. Given these three items stem from the concept of workload control in HVLV manufacturing (Hendry et al. 2013), the construct's name was also changed to suit.

In terms of the items associated with the Sales construct, Sales3, whilst a prevalent item in HVLV manufacturing literature (Petroni et al. 2017), required simplification according to the same discussions held after the content validity questionnaire. In this instance, Sales3 was modified to read "we understand our customers' objectives." Furthermore, Sales itself held two distinct activities in Quotation Management (Sales 1-3) and Coordination (Sales 4-6).

Appendix A presents the final measures for the PPC construct.

Human Resource Management

HRM literature provides an exhaustive list of management practices that appear better than others at delivering organisational performance outcomes (Úbeda-García et al. 2018). Because we adopt the notion of BMP, it would be fitting to adopt similar measures as those within the domain. Thus, our measures of HRM practices were adapted from the mass-scale survey studies on BMP (Bloom and Van Reenen 2006, Agarwal et al. 2014). Hence, we adapted the more qualitative scale developed by Bloom and Van Reenen (2006).

Considering measures were adapted into this research context, achieving content validity required more than an extensive literature review process. Hence, the CVI was calculated in this case (shown in Appendix B).

The results suggest that the scale needs some adjustment. The S-CVI is below the recommended threshold of 0.8 (Polit and Beck 2006). It is also apparent that HRM2 and HRM3 require further

attention from their low modified Kappa statistic. Like PPC, a post-hoc validation exercise through reviewing comments made by the participants in the CVI study revealed that HRM2 and HRM3 required revised measures, which were more comprehensible and reflect the consensus amongst HRM authorship in general (see details in Appendix A).

3.2 Survey Design and Data Collection

The final survey was split into four sections. Section A collected both generic organisational characteristics such as size and those more specific to HVLV manufacturing (e.g. product characteristics). Section B, C, and D all adopted a five-point Likert scale for analysis. Section B focussed on the extent to which BMP was adopted in the organisation while Section C was used to grasp the extent of ambidextrous capabilities the HVLV manufacturer held. Lastly, Section D was used to discern the HVLV manufacturers performance.

Given the increased risk of higher non-response rates and the nature of the research as an inherently strategic enquiry, as with other studies in this domain (c.f. Kortmann et al. 2014), we adopt the key informant approach where the survey was sent to single key-decision makers in HVLV manufacturers within Australia. Even though single key respondents are particularly useful in research concerning organisational phenomena in SMEs, self-reporting bias in single informant studies remains a concern (Flynn et al. 2018). To combat this, we implemented multiple measures that included 1) an invitation letter that was both appealing to manufacturers and demonstrated good research practice, 2) providing official research documentation (approvals and ethics documents), 3) providing incentives and promotions by way of a personalised executive summary and discounted entry to academic conferences and 4) randomised and carefully structured questions so as to avoid any sensitivity issues.

Once a pilot study was conducted – using five academics and one HVLV manufacturing industry professional for feedback - the survey was delivered using multiple delivery methods. Firstly, a list of 415 HVLV manufacturers was developed using a free online business directory and search terms based on ANZSIC codes that most resembled HVLV manufacturers. Similar to the approach adopted by Salvador and Forza (2004), expert judgement, by way of one authors' practical experience in HVLV manufacturing, as well as the characterisation of HVLV manufacturers in literature were used to identify the following ANZSIC codes: 2741, 2759, 2864. Cold calling was then deemed appropriate to maximise the response rate through conjuring interest in the research and building a rapport with potential respondents. Those that responded favourably provided direct email addresses to key decision makers. Out of 106 HVLV manufacturers that were contacted, 63 provided valid emails and 11 responses were received. A decision was then taken to email the remaining HVLV manufacturers

gathered from the business directory using publicly available contact information. Thus, 309 survey invitations were sent, and 36 responses were returned.

A mailing list was then purchased from a list broker tailored to the ANZSIC codes used previously. 756 invitations were sent and only three responses were received. The survey management tool used to deliver the questionnaire indicated that only 138 emails reached their intended recipients, the rest had either bounced back or remained unopened. It was evident that the majority of emails were not personalised to any one individual and, as was the case for Aslan et al. (2015), significantly reduced the effectiveness of this approach. A specialist list broker was thus approached to provide personalised emails for key decision makers in HVLV manufacturing organisations, again based on the initial ANZSIC codes. Here, 328 invitations were sent, and 23 completed responses were received.

After four rounds of data collection (with each round consisting of three reminder emails two weeks apart), 838 survey invitations were successfully sent. We received 73 surveys, revealing an overall response rate of around 9%, not uncommon for HVLV manufacturing research (Aslan et al. 2015).

After accounting for firms that had less than five employees (9), excessive missing data (13), and suspicious response patterns (1), a total of 23 questionnaires were removed from sample, leaving 50 valid responses.

3.3 Respondent Profile and Descriptive Statistics

Appendix C provides the respondent profile and generic organisational characteristics of HVLV manufacturers. Most respondents appeared to be key decision makers in HVLV manufacturers while the remainder of the sample consisted of middle management positions, including those related to estimation and sales.

In HVLV manufacturing, middle management typically refers to department heads (e.g., fabrication manager and machine shop manager) that hold key decisions in resource allocation and work-routing (c.f. Clegg and Fitter 1981). The project-based nature of operations means that most day-to-day problem-solving activities are undertaken by these middle managers, indicating their in-depth knowledge of operational phenomena. In a strategic sense, it is also important to note that strategic decisions in a HVLV manufacturing environment typically concern job acceptance, sales, and estimation decisions (Kingsman et al. 1996). Thus, the entry into new markets and the decision to build capabilities underline the job opportunities in a season. Middle management is critical here as they present the conduit from which strategic decisions are developed and enacted (Wolf and Floyd 2017); thus, the efficacy of strategic decision making also depends on them.

In terms of organisational characteristics, consistent with extant HVLV manufacturing literature (Stevenson et al. 2005), most of the sample consisted of well-established firms that fit an SME profile, less than 200 employees. Also, the HVLV manufacturers in this sample serviced a variety of industries (16 in total), most of which include the manufacture of sheet metal and structural steel products (16% each), agricultural machinery and equipment (11%), mining and construction machinery (11%) as well as the manufacturer of machine tools and parts (9%).

In line with our characterisation of HVLV manufacturing, all respondents undertook some level of customisation activities with 38% undertaking extensive customisation work where each product is different from the other and there are no repeat orders; 36% undertaking extensive customisation work as above, however, with some degree of repetition; 22% making a mixture of custom and standard products; and only 4% manufacturing primarily standardised products.

4 Analysis and Results

The research model was assessed using partial least squares structural equation modelling (PLS SEM). Apart from the commonly cited advantages in dealing with smaller sample sizes (Hair et al. 2019), as a variance-based approach adopted in a variety of research settings (Peng and Lai 2012, Ringle et al. 2012), it is also regarded to be a robust analysis technique in studies concerning management practices given its ability to model both composites and factors (Peng and Lai 2012) as well as those characterised by formative-reflective measures (Hair et al. 2017).

As with other PLS studies with relatively small sample sizes (Agarwal et al. 2018), we adopt a dual-stage approach in our analysis by firstly assessing the reliability and validity of the measurement (outer) model, followed by an assessment of the structural (inner) model. The analysis of the PLS SEM model was conducted using SmartPLS 3 software.

4.1 Evaluation of the Measurement Model

The measurement model was evaluated based on the type of relationship between indicators and their constituent variables. For reflective measures, indicator loadings, internal consistency reliability, convergent validity, and discriminant validity are assessed (Hair et al. 2019).

As the table in Appendix A demonstrates, most indicators had reasonable factor loadings (ranging from 0.611 to 0.944) - given values greater than 0.7 are generally regarded as acceptable (Peng and Lai 2012). Removal of some indicators in the region of 0.611 resulted in minor improvements towards internal consistency reliability, which posed concerns over convergent validity and were thus retained. However, the indicator HRM6 observed a loading of 0.489, which was far below the recommended guidelines and was removed. Internal consistency reliability was measured according

to both the composite reliability of the measure and the P_A value. Here, all values lied between approximately 0.6 and 0.95, also demonstrating good internal consistency reliability (Hair et al. 2017). Convergent validity was assessed based on the average variance extracted (AVE) where all measures observed values greater than 0.5 – thus, acceptable. Finally, discriminant validity was assessed by using the more contemporary heterotrait-monotrait (HTMT) ratio where correlations between variables should be less than one (Henseler et al. 2015) (See Appendix D).

A different approach is undertaken to assess the reliability and validity of the second-order reflective-formative factors in the model. Here, collinearity and statistical significance, and relevance are typically assessed (Hair et al. 2019). Collinearity is assessed using the variance inflation factor (VIF) and a bias-corrected accelerated (BCa) bootstrapping procedure using 5000 subsamples for testing the statistical significance and relevance. As Table 2 illustrates, all VIF values for the second-order constructs are less than three, thus demonstrating collinearity is not problematic (Hair et al. 2017). Besides, the respective *t* and *p* statistics resemble those of statistical relevance and significance – further indicating the reliability and validity of these higher-order constructs.

Table 1 Second-Order Reflective-Formative Measure Evaluation

	Weights	**T-values**	**VIF**
Ambidexterity			
Exploration	0.558	11.540***	1.891
Exploitation	0.530	11.705***	1.891
PPL			
Quotation Management	0.331	9.044***	2.113
Workload Control	0.437	10.729***	2.000
Coordination	0.400	11.531***	1.852

***p<0.001

4.2 Evaluation of the Structural Model

The structural model evaluation was conducted using Smart PLS 3 based on recommended guidelines for organisation research by Hair et al. (2017). Here, 5000 subsamples were adopted using a BCa procedure based on a significance level of 0.05 and two-tailed testing. The results of the direct relationships in the structural model assessment are shown in Table 3, including the effects of control variables.

Table 2 PLS SEM Results for Direct Relationships with Control Variables

						Confidence Interval	
Hyp.	**Relationship**	**Std**	***t***	***p***	**Outcome**	**2.5%**	**97.5%**

		Beta	value	value			
H1a	Ambidexterity → HRM	0.653	4.698	0.000	Supported	0.312	0.833
H1b	HRM → Operational Flexibility	-0.055	0.379	0.705	Not Supp.	-0.345	0.222

						Confidence Interval	
Hyp.	**Relationship**	**Std Beta**	***t* value**	***p* value**	**Outcome**	**2.5%**	**97.5%**
	Age -> HRM	0.101	0.879	0.380	Not Sign.	-0.131	0.330
	Age -> PPC	0.261	1.791	0.073	Not Sign.	-0.050	0.524
	Age -> Operational Flexibility	-0.037	0.336	0.737	Not Sign.	-0.264	0.178
	Age -> Process Innovation	0.076	0.623	0.533	Not Sign.	-0.173	0.313
	Size -> HRM	0.005	0.038	0.970	Not Sign.	-0.252	0.260
	Size -> PPC	-0.130	1.238	0.216	Not Sign.	-0.325	0.080
H1c	HRM → Process Innovation	0.484	3.140	0.002	Supported	0.185	0.796
H2a	Ambidexterity → PPC	0.646	4.698	0.000	Supported	0.307	0.842
H2b	PPC → Operational Flexibility	0.492	3.257	0.001	Supported	0.218	0.810
H2c	PPC → Process Innovation	0.012	0.063	0.950	Not Supp.	-0.381	0.341
H3a	Ambidexterity → Operational Flexibility	0.188	1.054	0.292	Supported	-0.201	0.486
H3b	Ambidexterity → Process Innovation	0.120	0.661	0.509	Supported	-0.253	0.461

	Size -> Operational Flexibility	0.263	2.542	0.011	Significant	0.073	0.479
	Size -> Process Innovation	-0.034	0.275	0.784	Not Sign.	-0.250	0.246
	Construct	**R^2 Adj.**	**Q^2**				
	HRM	0.381	0.291				
	PPC	0.401	0.324				
	Operational Flexibility	0.344	0.261				
	Process Innovation	0.256	0.127				

Mediation analysis was undertaken by investigating the specific indirect effects within SmartPLS 3. Understanding the limitations of traditional, piecemeal approaches to mediation analysis (Zhao et al. 2010), and in line with more recent PLS SEM studies with relatively small sample sizes (e.g. Agarwal et al. 2018), we have opted to test for parallel mediation based on the entire model by a bootstrapping procedure similar to that described in the test for direct relationships earlier. The results of this analysis are shown in Table 4.

Table 3 PLS SEM Mediation Analysis

Indirect Relationship	**Std Beta**	**t-value**	**p-value**	**Outcome**	**97.5% CI LL**	**97.5% CI UL**
Ambidexterity -> HRM -> Flexibility	-0.036	0.369	0.712	No Mediation	-0.240	0.149
Ambidexterity -> HRM -> Process Innovation	0.316	2.445	0.015	Full Mediation	0.087	0.581
Ambidexterity -> PPC -> Flexibility	0.318	2.332	0.02	Full Mediation	0.103	0.626
Ambidexterity -> PPC -> Process Innovation	0.008	0.061	0.952	No Mediation	-0.270	0.232

4.3 Common Method Bias

Given the research design involves a single respondent in each organisation, a post-hoc analysis for common method bias was conducted. To accomplish this, and in line with Kortmann et al. (2014), Harman's single factor test was adopted (Podsakoff and Organ 1986). Here, we assess the extent to which a single factor accounts for the majority of the variance. Based on an unrotated principal component analysis concerning all items used in the model, the results suggest that 33.657% of the variance can be explained by one factor. Thus, common method bias does not seem to be problematic.

5 Discussion and Conclusions

5.1 Implications to Theory

In general, our results resemble the configurational approach to DC (Wilden et al. 2016) in the role of higher-order (dynamic) capabilities in some way shaping lower-order or operational (Helfat and Winter 2011, Winter 2003) routines which subsequently impact organisational performance outcomes (Protogerou et al. 2011, Waleczek et al. 2019). This presents some contrast towards other proponents of the capabilities-based theory of the firm whereby ordinary capabilities (BMP) may not be as crucial to competitive advantage as DC. For example, a firm with good DC and poor ordinary capabilities, will presumably outlast a firm with poor DC and excellent ordinary capabilities (Teece 2017). Such a perspective, however, also recognises the key role management practices play in this relationship, suggesting that this is only the "tip of the iceberg in the way that management matters"(Teece 2017, p. 23). We intend to begin to shed some light on what lies beneath.

Firstly, our results concerning the positive impact of ambidextrous (dynamic) capabilities on BMP are consistent with the broader notion that DC plays a crucial role in the implementation process of adoptive managerial innovations, i.e., those that already exist and are readily identifiable (Lin et al. 2016). Here, we add to the emerging viewpoint that DC helps an organisation seek-out, assess, and enact BMP (Khosravi et al. 2019), thus increasing the odds of adoption (Lin et al. 2016). This view also aids in understanding BMP as complementary lower-order capabilities given the higher-order counterpart typically helps in achieving a greater appreciation and awareness of their use in practice (Schilke 2014).

Besides, the fully mediating role of BMP in the link between ambidextrous capabilities and organisational performance outcomes we uncovered also conforms to recent arguments in the broader DC literature concerning the mediating role of ordinary capabilities in the link between DC and organisational performance (c.f. Waleczek et al. 2019). This also provides some strength to the more conceptual discussions on ambidexterity as a higher-order capability (Zimmermann and Birkinshaw 2016) and flips the narrative of BMP in helping to build ambidextrous capabilities (e.g. Matthews et al. 2015), to one where BMP play a more central role in the deployment of the capability throughout the organisation. This relationship, however, appears contingent on the characteristics of the BMP themselves, showing two possible "dynamic bundles" (Waleczek et al. 2019) that impact organisational performance differently.

PPC practices demonstrated a fully mediating relationship with operational flexibility. However, contrary to PPC notions as an inherently innovative exercise in HVLV manufacturing (Petroni et al. 2017), our results did not support the latter. Similarly, with HRM practices, whereby process

innovation was impacted, and operational flexibility was not. Thus, whilst we can contend that pursuing a mutually synergistic relationship between exploratory and exploitative activities can emerge through PPC and HRM, the way this DC becomes embedded in these BMP leaves their outcomes open to the idiosyncrasies associated with their application in practice.

Furthermore, this paper substantiates the conceptual arguments presented in earlier work by Katic et al. (2019) concerning the potential for BMP to help HVLV manufacturers in deploying ambidexterity. Building off the apparent bias towards exploitation in HVLV manufacturing literature (Katic and Agarwal 2018), we extend these contributions by empirically demonstrating the dual-nature of capability investments in ambidexterity and BMP towards exploratory and exploitative HVLV manufacturer performance outcomes. This finding carries significant implications for HVLV manufacturing practitioners.

5.2 Implications for Managers

The research presented herein poses a fundamentally practice-based question. Even though it is general in understanding how ambidextrous capabilities can be deployed through BMP, the HVLV manufacturing case poses beneficial managerial guidelines for key decision-makers.

Firstly, we highlight the peculiarities of successfully running a highly flexible manufacturing organisation. We illustrate how the flexibility inherent in HVLV manufacturing enterprises can be to their detriment. On the one hand, flexibility can cause such organisations to revert to exploitative measures to counter environmental dynamism inadvertently. On the other hand, flexibility brings exploration and forfeit opportunities to build capabilities necessary to compete in the short-term (Katic and Agarwal 2018). Indeed, both are required, and, as we have demonstrated, ambidextrous capabilities drive the adoption of BMP. For managers, this means maximizing the tensions brought forward when undertaking each project towards synergistic outcomes – proving crucial to the pursuit of long-term competitive advantage through the adoption of BMP.

Secondly, PPC and HRM have observed increased attention from researchers in HVLV manufacturing (Petroni et al. 2017). Though, it appears their contradictory effects have been somewhat taken for granted. In the case of PPC, for instance, the classic “job shop problem” and “lead-time syndrome” have been plaguing researchers for decades (Stevenson et al. 2005). This paper aims to improve visibility, increase responsiveness to change, and improve decision-making capabilities for managers by helping make sense of the chaos in a more meaningful manner (Stevenson and Vanharanta 2015). However, we urge HVLV managers to carefully consider adopting PPC measures while proving crucial in leveraging their ambidexterity capabilities and increasing their ability to make a host of highly customised products. Since these capabilities also prove to be a barrier to ongoing operational

renewal. Thus, while PPC measures help HVLV organisations do things right, they do not necessarily help do the right things.

In the case of HRM practices, it would appear to be the opposite. Again, proving crucial in leveraging their ambidexterity towards favourable performance outcomes appears detrimental when operational flexibility is concerned. We would recommend the selective use of these measures. However, there is more to this phenomenon stemming from the heterogeneity in HVLV manufacturing enterprises themselves (Amaro et al. 1999). While this claim cannot be substantiated from the evidence provided thus far, we can attest that HRM practices may see decreased relevance in HVLV manufacturing associated with more repeat business than those that conduct engineering activities more often.

5.3 Limitations and Potential for Further Research

While demonstrating significance across multiple domains in ambidexterity, operations, and HVLV manufacturing literature, this paper is not without its limitations.

Firstly, this research's comparatively small sample size has constrained overall generalisability and limited the capabilities in adopting more advanced inference techniques to cover a wide suite of BMP. Though meeting the minimum sample size requirements in terms of model complexity and size (see the post-hoc power assessment in Hair et al. 2017), care should be taken to interpret these results, particularly when full mediation is concerned (Rucker et al. 2011).

Secondly, although measures were taken to reduce common method bias and self-reporting through the research design, a single key decision-maker was surveyed. Ambidexterity occurs at multiple levels of organisation (Birkinshaw and Gupta 2013). Thus a richer understanding can be obtained by investigating how ambidexterity can manifest at different organization levels. Further research could also extend our contributions by adopting a longitudinal research method based on an organisation’s ambidexterity journey over time.

Third, further research is required to test the maximisation perspective of ambidexterity in HVLV manufacturers. Whilst we can certainly attest to this perspective's credibility, both theoretically and empirically, there lies an opportunity to strengthen these findings by adopting different perspectives on ambidextrous capabilities (Luger et al. 2018).

Finally, context plays an essential role in both the characterisation of HVLV manufacturers and BMP. HVLV manufacturing strategies can span both engineer-to-order and make-to-order strategies (Katic and Agarwal 2018). Further research is encouraged to substantiate these nuances.

Appendix A: Measurement Model Evaluation (Reflective Constructs)

Construct	Items	Description	Status	Loadings	AVE	CR	Rho A
Exploitation*	Exploit1	We commit to improving quality and lowering costs	Adopted	0.699	0.548	0.861	0.818
(Lubatkin et al. 2006)	Exploit2	We strive to continuously improve the reliability of our products and/or services	Adopted	0.802			
	Exploit4	We constantly questionnaire the customer satisfaction levels of our existing customer base	Adopted	0.673			
	Exploit5	We fine-tune what we offer to keep our current customers satisfied	Adopted	0.835			
	Exploit6	We place focus on penetrating more deeply into our existing customer base	Adopted	0.679			
Exploration*	Explore1	We look for novel technological ideas by thinking outside the box	Adopted	0.774	0.556	0.858	0.809
(Lubatkin et al. 2006)	Explore2	We base our success on our ability to explore new technologies	Adapted	0.747			
	Explore4	We look for creative ways to satisfy our customer needs	Adapted	0.83			
	Explore5	We aggressively venture into new market segments	Adopted	0.749			
	Explore6	We actively target new customer groups	Adapted	0.611			
HRM*	HRM1	Senior managers are evaluated and held accountable for the strength of the talent pool they actively build	Adapted	0.643	0.520	0.843	0.797
(Bloom and Van Reenen 2006)	HRM2	We adopt an appropriate performance-based rewards and accountability system linked to organisational targets	Adapted	0.706			
	HRM3	We adopt different strategies (remove, reallocate and/or develop employees) to manage our underperformers	Adapted	0.682			
	HRM4	We actively identify, develop and promote our top performers	Adapted	0.754			
	HRM5	We provide a unique value proposition above our competitors to	Adapted	0.810			

Construct	Items	Description	Status	Loadings	AVE	CR	Rho A
		encourage talented people to join our company					
Quotation Management	Sales1	We keep track of and monitor all quotation (both won and lost) in an easy access database	Adapted	0.717	0.546	0.782	0.599
(See Table 1 for key references)	Sales2	We have a keen understanding of our competitors and employ a systematic quotation control system in order to help guide cost and lead time estimations for customer enquiries (for example, a strike-rate matrix)	Adapted	0.818			
	Sales3	We understand our customers' objectives	Adapted	0.674			
Coordination	Sales4	There is a high degree of coordination between all departments to ensure we set realistic due dates for customer enquiries	Adapted	0.828	0.690	0.87	0.789
(See Table 1 for key references)	Sales5	Capacity and resource availability information is readily available to both manufacturing and sales departments when responding to customer enquiries	Adapted	0.857			
	Sales6	There is a high degree of coordination between our organisation and our suppliers when we respond to customer enquiries	Adapted	0.807			
WLC	PPC1	We implement a systematic method of workload control	Adapted	0.875	0.758	0.904	0.840
(See Table 1 for key references)	PPC3	We have a systematic method of bottleneck detection and reduction	Adapted	0.853			
	PPC4	Job priorities are clearly understood by everyone on the shop floor	Adopted	0.883			
Flexibility	Perf_Flex1	(Ability to) customise products	Adopted	0.665	0.605	0.857	0.960
(Swink et al. 2005)	Perf_Flex2	Adjust production volumes	Adopted	0.879			
	Perf_Flex3	Respond to changes in delivery requirements	Adopted	0.904			
	Perf_Flex4	Produce a range of products	Adopted	0.624			
Process Innovation	Perf_Innov_Proc1	Technological competitiveness	Adopted	0.861	0.79	0.937	0.920

Construct	Items	Description	Status	Loadings	AVE	CR	Rho A
(Prajogo and Sohal 2003)	Perf_Innov_Proc2	Novelty of technology used	Adopted	0.885			
	Perf_Innov_Proc3	Speed of adoption of latest technology	Adopted	0.944			
	Perf_Innov_Proc4	The rate of change in processes and technology	Adopted	0.862			

*Exploit3, Explore3, HRM6 and PPC4 removed due to validity and reliability concerns.

[a] Loadings < 0.600 were dropped [b] AVE < 0.5000 [c] CR < 0.700 [d] Rho A < 0.6

Appendix B: Results of the content validity testing for production planning and control and human resource management constructs

Code	No. of 4-5 rating	I-CVI**	P_c***	K****	Interpretation
Sales1	10	0.769	0.070	0.752	Excellent
Sales2	10	0.769	0.070	0.752	Excellent
Sales3	8	0.615	0.314	0.439	Fair
Sales4	12	0.923	0.003	0.923	Excellent
Sales5	13	1	0	1	Excellent
Sales6	9	0.692	0.175	0.627	Good
	S-CVI (Average)*	0.795			

Code	No. of 4-5 rating	I-CVI**	P_c***	K****	Interpretation
PPC1	12	0.923	0.003	0.923	Excellent
PPC2	11	0.846	0.019	0.843	Excellent
PPC3	12	0.923	0.003	0.923	Excellent
PPC4	12	0.923	0.003	0.923	Excellent
PPC5	13	1	0	1	Excellent
PPC6	12	0.923	0.003	0.923	Excellent
	S-CVI (Average)*	0.923			

Code	No. of 4-5 rating	I-CVI**	P_c***	K****	Interpretation
HRM1	12	0.923	0.003	0.923	Excellent
HRM2	7	0.538	0.419	0.206	Poor
HRM3	6	0.462	0.419	0.073	Poor
HRM4	11	0.846	0.019	0.843	Excellent
HRM5	12	0.923	0.003	0.923	Excellent
HRM6	11	0.846	0.019	0.843	Excellent
	S-CVI (Average)*	0.756			

*S-CVI is the scale content validity index, **I-CVI is the individual content validity index, *** P_c is the probability of chance occurrence, ****K is the modified Kappa statistic where 0.74 is excellent, 0.6-0374 is good and values from 0.59-0.4 can be considered fair.

Appendix C: Respondent Profile and Descriptive Statistics

Respondent Descriptive Statistics	**N**	**% (rounded)**
Role		
CEO/Owner/Director	31	62
General Manager	12	24
Middle Management	4	8
Other	3	6
Tenure (years)		
Less than 5	8	16
5-10	8	16
11-15	12	24
16-20	6	12
More than 20	16	32
Generic Organisational Descriptive Statistics	**N**	**% (rounded)**
Size (No. of employees)		
5-19	29	58
20-99	19	38
100-199	2	4
Age (years operational)		
5-10	1	2
11-15	6	12
16-20	7	14
More than 20	36	72

Appendix D: Discriminant validity testing using the heterotrait-monotrait ratio

	Age	Coordination	HRM	Quotation Management	Size	Workload Control	Exploitation	Exploration	Operational Flexibility	Process Innovation
Age										
Coordination	0.128									
HRM	0.106	0.516								
Quotation Management	0.279	0.872	0.595							
Size	0.05	0.116	0.245	0.172						
Workload Control	0.176	0.644	0.582	0.941	0.107					
Exploitation	0.137	0.688	0.808	0.738	0.104	0.638				
Exploration	0.179	0.614	0.65	0.498	0.248	0.447	0.82			
Operational Flexibility	0.162	0.564	0.384	0.679	0.304	0.447	0.452	0.546		
Process Innovation	0.105	0.294	0.649	0.471	0.016	0.314	0.414	0.471	0.383	

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