The development and validation of the organisational innovativeness construct using confirmatory factor analysis

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Keywords

Organizational innovation, Factor analysis

Abstract

The role of organisational innovativeness, or innovative capability, in attaining competitive advantage has been widely discussed. Most research examines innovation activities and their associations with organisational characteristics, or investigates certain perspectives of innovative capability, such as product innovation. Much less attention, however, has been paid to develop and validate measurement constructs of organisational innovativeness. Through an extensive literature review, five dimensions of an organisation's overall innovativeness are identified. These five dimensions form the component factors of the organisational innovativeness construct. Following a three-step approach, a final 20-item measurement construct is validated. Theoretical and methodological issues in relation to application of the organisational innovativeness construct are discussed in light of these findings.

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Introduction

The literature of innovation is long-standing. An organisation's ability to innovate is recognised as one of the determinant factors for it to survive and succeed (Doyle, 1998; Quinn, 2000). However, there is little empirical evidence in terms of development and validation of organisational innovativeness scales. Authors, such as Miller and Friesen (1983), Capon *et al.* (1992), Avlonitis *et al.* (1994), Guimaraes and Langley (1994), Subramanian and Nilakanta (1996), Hurley and Hult (1998), Lyon *et al.* (2000) and North and Smallbone (2000), address the concern of measuring organisational innovativeness effectively. However, the primary focus of these studies is not scale development. As such, the measures used are often *ad hoc* and do not conform to systematic procedures for scale development.

Second, scales used in the area of innovative capability often adopt a certain perspective, such as product innovativeness (see Song and Parry, 1997; Sethi *et al.*, 2001; Danneels and Kleinschmidt, 2001) instead of overall innovative capability. Product innovativeness emphasises the outcome-oriented innovative capability, but undermines the importance of underlying factors, such as behavioural changes, process innovation and strategic orientation towards innovation.

Additionally, a prime interest in the existing literature is to investigate innovation activities and their associations, where adoption of one or more innovations is examined as the dependent variable and linked to attributes of the organisation, the individual respondent, and the innovation itself (Gallivan, 2001). This stream of research views innovation narrowly, often unidimensionally, neglecting multiple facets pertinent to the domain. This has led to confusion in innovation research, either making it difficult to compare findings across studies or leading to biased conclusions (Zaltman *et al.*, 1973; Tushman and Anderson, 1986; Utterback, 1994; Subramanian and Nilakanta, 1996; Cooper, 1998).

The above is one of the reasons why the extant innovation literature often does not arrive at consensus over many issues. Reconciling the contradiction and confusion requires a validated measurement scale of an organisation's overall innovative capability, i.e. the propensity or likelihood that an organisation produces innovative outcomes. The objective of this paper is to develop an organisational innovativeness construct and assess its validity and reliability. Component factors and key variables for the construct are identified through extensive literature review. Confirmatory factor analysis is performed using AMOS 4.0 to check on the

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construct and identify the model fitness. This is conducted by following a three-step process of data pruning, second-order confirmatory factor analysis, and nested models.

Theoretical development of the organisational innovativeness construct

Innovation may be present in various forms, such as product or process innovation, radical or incremental innovation, administrative or technological innovation, etc. (Zaltman *et al.*, 1973; Utterback, 1994; Cooper, 1998). The importance of different dimensions is emphasised by authors. For example, Schumpeter (1934) suggests a range of possible innovative alternatives, namely developing new products or services, developing new methods of production, identifying new markets, discovering new sources of supply, and developing new organisational forms. Miller and Friesen (1983) focus on four dimensions: new product or service innovation, methods of production or rendering of services, risk taking by key executives, and seeking unusual and novel solutions. While Capon *et al.* (1992) adopt three dimensions of organisational innovativeness: market innovativeness, strategic tendency to pioneer, and technological sophistication. From various research, we identify five main areas that determine an organisation's overall innovativeness. They are product innovativeness, market innovativeness, process innovativeness, behavioural innovativeness, and strategic innovativeness. Research emphasising these different dimensions is briefly summarised in Table I. In line with these perspectives, we define organisational innovativeness as "an organisation's overall innovative capability of introducing new products to the market, or opening up new markets, through combining strategic orientation with innovative behaviour and process".

Product innovativeness

Product innovativeness (Zirger, 1997) has been a major interest (Masaaki and Scott, 1995; Schmidt and Calantone, 1998), in that it is a critical antecedent to product success (Zirger, 1997; Sethi *et al.*, 2001), which in turn is highly associated to sustainable business success (Henard and Szymanski, 2001). Innovative products present great opportunities for businesses in terms of growth and expansion into new areas. Significant innovations allow companies to establish dominant position in the competitive marketplace, and afford new entrants an opportunity to gain a foothold in the market (Danneels and Kleinschmidt, 2001).

Product innovativeness is most often referred to as perceived newness, novelty, originality, or uniqueness of products (Henard and Szymanski, 2001). This perceived newness encompasses two perspectives: from the consumers' perspective and the firm's perspective (Atuahene-Gima, 1995; Cooper and de Brentani, 1991; Danneels and Kleinschmidt, 2001). Andrews and Smith (1996) consider appropriateness, the extent to which a new product is viewed as useful or beneficial to some consumers, as an important feature of product innovativeness.

There is also a propensity in the literature to incorporate various other perspectives of innovativeness in product innovativeness. For example, Danneels and Kleinschmidt (2001) incorporate two perspectives of product innovativeness:

(1) From the customers' perspective, characteristics such as innovation attributes, adoption risks, and levels of change in established behavioural patterns are regarded as forms of product newness.
(2) From the firm's perspective, environmental familiarity and project-firm fit, and technological and marketing aspects are viewed as dimensions of product innovativeness.

In this paper, we define product innovativeness as the novelty and meaningfulness of new products introduced to the market at a timely fashion. This distinguishes product innovativeness from other innovative factors as discussed below. Thus, product innovativeness can be regarded as a salient dimension.

Table I Dimensions of organisational innovativeness

Author	Product	Market	Process	Behaviour	Strategic
Schumpeter (1934)	×	×	×		
Miller and Friesen (1983)	×		×	×	×
Capon *et al.* (1992)		×			×
Avlonitis *et al.* (1994)	×		×	×	×
Subramanian and Nilakanta (1996)			×		
Hurley and Hult (1998)				×	
Rainey (1999)				×	×
Lyon *et al.* (2000)	×		×		
North and Smallbone (2000)	×	×	×	×	

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Market innovativeness

Market innovativeness is highly connected to product innovativeness, and often studied as product-market innovativeness (Schumpeter, 1934; Cooper, 1973; Miller, 1983). In fact, Ali *et al.* (1995) consider innovativeness as a market-based construct and define innovativeness as the uniqueness or novelty of the product to the market. At a broader level, market innovativeness refers to innovation related to market research, advertising and promotion (Andrews and Smith, 1996), as well as identification of new market opportunities and entry into new markets (Ali *et al.*, 1995).

As a component factor separate from product innovativeness, we refer to market innovativeness as the newness of approaches that companies adopt to enter and exploit the targeted market. For some companies, this means that they can enter a market or identify a new market niche and launch products with cutting-edge technological content. An alternative approach would be based on existing products, but with adoption of new marketing programmes to promote the products and services. Under both circumstances, the company is very likely to take up against new competitors either in a new market, or an existing market segment.

While product innovativeness maintains a central focus of product newness, market innovativeness emphasises the novelty of market-oriented approaches. Although they are treated as salient factors, product and market innovativeness are inevitably inter-twined.

Process innovativeness

Process innovativeness is not often explicitly discussed in the literature. In most studies, process innovativeness is considered as a sub-element of technological innovativeness. For example, Kitchell (1997) considers technological innovativeness is best examined in light of the nature and process of innovation adoption. Avlonitis *et al.* (1994) consider technological innovation challenges in relation to machinery and production methods as measures for technological innovativeness.

In our view, technological innovativeness is embedded in either product innovativeness that embodies the unique, novel technological content in new products, or process innovativeness that exploits new equipments of technological advancement. Hence, technological innovativeness is not considered as a salient factor in this research.

Therefore, we use process innovativeness, which captures the introduction of new production methods, new management approaches, and new technology that can be used to improve production and management processes. Process innovativeness is imperative in overall innovative capability, in that an organisation's ability to exploit their resources and capabilities, and most importantly, the ability to recombine and reconfigure its resources and capabilities to meet the requirement of creative production is critical to organisational success.

Behavioural innovativeness

Behavioural innovativeness can be present at different levels: individuals, teams and management. Measuring behavioural innovativeness of an organisation cannot be accomplished simply by examining occasional innovation events, or innovative characteristics of certain small groups in the organisation. The behavioural dimension should reflect the "sustained behavioural change" of the organisation towards innovations, i.e. behavioural commitment (Avlonitis *et al.*, 1994).

Individual innovativeness can be considered as "a normally distributed underlying personality construct, which may be interpreted as a willingness to change" (Hurt *et al.*, 1977). Team innovativeness is the team's adaptability to change (Lovelace *et al.*, 2001). It is not simply a sum of innovative individuals, but a synergy based on the group dynamics. While managerial innovativeness demonstrates management's willingness to change, and commitment to encourage new ways of doing things, as well as the willingness to foster new ideas (Rainey, 1999).

Behavioural innovativeness demonstrated through individuals, teams and management enables the formation of an innovative culture, the overall internal receptivity to new ideas and innovation. Behavioural innovativeness is a fundamental factor that underlines innovative outcomes. Innovative culture serves as a catalyst of innovations, while lack of it acts as blocker of innovations.

Strategic innovativeness

Strategic innovation is about "a fundamental reconceptualisation of what the business is all about that, in turn, leads to a dramatically different way of playing the game in an existing business" (Markides, 1998). Strategic innovation takes place when a company identifies gaps in industry positioning, goes after them, and the gaps grow to become the new mass market. In a broad sense, Besanko *et al.* (1996) define strategic innovation as the development of new competitive strategies that create value for the firm. The primary focus of strategic innovativeness in this paper is to measure an organisation's ability to manage ambitious organisational objectives, and identify a mismatch

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of these ambitions and existing resources in order to stretch or leverage limited resources creatively.

In many organisations, strategic innovation faces many obstacles. A typical scenario is one in which companies are very successful in their existing markets, and do not feel any urge to change. Under other circumstances, companies have already recognised the need to change, but do not have the capabilities of managing the change, or executives hesitate to take risks due to uncertainty of change (Markides, 1998).

Empirical research on strategic innovativeness is very limited. The majority of authors do not consider strategic innovativeness as a component factor of organisational innovativeness, while some others include a single item of strategic innovativeness. For example, Miller and Friesen (1983) view key executives' risk taking in seizing and exploring chancy growth opportunities as an important criterion of organisational innovativeness. Capon *et al.* (1992) consider a company's strategic tendency to pioneer as a dimension of organisational innovativeness. Avlonitis *et al.* (1994) include manifested strategic innovation intentions in measuring organisational innovativeness.

The above five aspects are inter-linked. In particular, product innovativeness and market innovativeness are inter-twined. They are externally-focused and market-based, whereas behaviour and process innovativeness are both internally-focused, and underline the need for product and market innovativeness. While strategic innovativeness highlights an organisation's ability to identify external opportunities in a timely fashion and match external opportunities with internal capabilities in order to deliver innovative products and explore new markets or market sectors. Product and market innovativeness embodies the process, behavioural, and strategic innovativeness. These five aspects together depict an organisation's overall innovativeness. We, therefore, propose the following research hypotheses:

H1. Though the organisational innovativeness construct is conceptualised as consisting of five distinct components (i.e. behavioural innovativeness, product innovativeness, process innovativeness, market innovativeness, and strategic innovativeness), the covariance among the 29 items can be accounted for by a single factor (i.e. a general organisational innovativeness factor).

H2. Covariance among the 29 items can be accounted for by a restricted five-factor model, wherein each factor represents a particular conceptual component of organisational innovativeness and each item is reflective only of a single component (i.e. loads only on one factor). The five factors are correlated.

H3. Responses to each item are reflective of two factors: a general organisational innovativeness factor and a specific component factor corresponding to one of the five conceptual components. Thus, the covariance among the items can be accounted for by a six-factor model.

Research methodology

A total of 29 items were generated from literature (see Table II). A questionnaire was used to collect empirical data. The questionnaire uses a seven-point Likert scale, ranging from 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neither disagree or agree, 5 = slightly agree, 6 = agree, 7 = strongly agree. A neutral response, "neither disagree or agree", was adopted to reduce uninformed response, since it assures respondents that they need not feel compelled to answer every questionnaire item (Wilcox, 1994).

A sample of 1,500 companies (with no less than 50 employees and a primary trading address within England, Wales, and Scotland) were randomly selected from the FAME Database, and were sent a questionnaire with a cover letter to the company director or senior executive, and a pre-paid return envelope. The initial letter was followed by two reminders. A total of 231 completed questionnaires were received, representing a 15.4 per cent response rate. The rate for the usable responses was 14.2 per cent.

To check the non-response bias, the analysis of variance (ANOVA) test was performed to confirm the existence or absence of bias, as suggested by Armstrong and Overton (1977). Respondents were divided into three groups: the first mailing, the first follow-up and the second follow-up. It was assumed that the last group who responded to the second follow-up were most similar to non-respondents (Armstrong and Overton, 1977). Using the ANOVA test, three groups were compared on all variables. The results revealed that there was no significant difference (at the 5 per cent significance level) between the three groups. Because the group sizes are unequal, the *post-hoc* Turkey's *b*-test using the harmonic means of the group sizes also evidenced that all the variables were homogenous (at the 5 per cent significance level) between three groups.

Confirmatory factor analysis is reckoned as a best-known statistical procedure for testing a hypothesised factor structure (Schumacker and

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Table II The organisational innovativeness construct

Code	Key variables	Mean	Standard deviation
IN01	In new product and service introductions, our company is often first-to-market	4.272	1.596
IN02	Our new products and services are often perceived as very novel by customers	4.305	1.416
IN03	Our recent new products and services are only minor changes from our previous products and services (R)	4.042	1.509
IN04	New products and services in our company often take us up against new competitors	3.887	1.583
IN05	In comparison with our competitors, our company has introduced more innovative products and services during the past five years	4.296	1.490
IN06	In comparison with our competitors, our company is faster in bringing new products or services into the market	–	–
IN07	In comparison with our competitors, our company has a lower success rate in new products and services launch(R)	4.554	1.297
IN08	In comparison with our competitors, our products' most recent marketing programme is revolutionary in the market	3.606	1.323
IN09	Our company's most recent new product introduction required a new form of advertising and promotion, different from that used for our existing products	–	–
IN10	In new product and service introductions, our company is often at the cutting edge of technology	3.864	1.739
IN11	The technology of our main machinery in use is very up-to-date	–	–
IN12	Our future investments in new machinery and equipment are significant compared with our annual turnover	–	–
IN13	In comparison with our competitors, we are late in adoption of technological innovations (R)	–	–
IN14	Our firm's R&D or product development resources are not adequate to handle the development need of new products and services (R)	3.977	1.615
IN15	The nature of the manufacturing process in our company is new compared with that of our main competitors	–	–
IN16	We are constantly improving our business processes	5.164	1.231
IN17	Our company changes production methods at a great speed in comparison with our competitors	3.906	1.202
IN18	Our future investments in new methods of production are significant compared with our annual turnover	–	–
IN19	During the past five years, our company has developed many new management approaches	4.732	1.400
IN20	We get a lot of support from managers if we want to try new ways of doing things	4.531	1.423
IN21	Management is very cautious in adopting innovative ideas (R)	–	–
IN22	Key executives of the firm are willing to take risks to seize and explore "chancy" growth opportunities	3.883	1.517
IN23	Management actively responds to the adoption of "new ways of doing things" by main competitors	–	–
IN24	Senior executives constantly seek unusual, novel solutions to problems via the use of "idea men"	3.648	1.451
IN25	In our company, we tolerate individuals who do things in a different way	4.413	1.430
IN26	We are willing to try new ways of doing things and seek unusual, novel solutions	4.455	1.456
IN27	We encourage people to think and behave in original and novel ways	4.432	1.511
IN28	When we see new ways of doing things, we are last at adopting them (R)	4.193	1.553
IN29	When we cannot solve a problem using conventional methods, we improvise on new methods	4.742	1.242

Notes: (R) denotes reverse coded item. Items with – under the mean and standard deviation columns are deleted in the respecified model

Lomax, 1996; Byrne, 2001). It is, therefore employed in this research. A total of 213 cases were processed using AMOS 4.0. The Maximum Likelihood (ML) estimation method was employed. A few assumptions need fulfilling in order to use the ML method:

- reasonable sample size (at least 200 cases);
- the scale of the observed variables are continuous;
- the hypothesised model is valid; and
- the distribution of the observed variables is multivariate normal.

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The data of this research met the first two criteria. The hypothesised model was developed from theories and some empirical findings, and thus was assumed valid. Finally the normality of the observed variables were tested, following the rules of thumb suggested by West *et al.* (1995): for a sample size of 200 or less, moderately non-normal data (univariate skewness < 2, univariate kurtosis < 7) are acceptable, i.e. the robust standard errors provides generally accurate estimates. Recent research also shows that ML estimation method can be used for data with minor deviations from normality (Raykov and Widaman, 1995). In our data, the univariate skewness of each variable is < 0.945 in absolute value. The univariate kurtosis of each variable is < 1.171 in absolute value. Thus, the fourth assumption of ML method was also met.

Data analysis

The analysis was conducted following three steps. In the first stage, all 29 items generated were included in the first-order measurement model for organisational innovativeness. The initial model fitness was assessed and subjected to respecification. In the second stage, a second order confirmatory factor analysis was performed based on the respecified model. Finally, nested models were reported to compare the accepted measurement model with other competing models.

To produce an over-identified model, the first regression path in each measurement component was fixed at 1. The criteria used to evaluate the items were each item's error variance estimate; evidence of items needing to cross-load on more than one component factor as indicated by large modification indices; the extent to which items give rise to significant residual covariance; parsimony purpose; regression coefficient of each item; reliability of the item and the reliability of the whole construct. Additionally, the logic and consistency of data with the theoretical framework was considered when evaluating each item.

Data pruning and first-order confirmatory analysis

The initial model fit indices were $x^2 = 862.079$, $x^2/\text{df} = 2.349$, df = 367, GFI = 0.776, AGFI = 0.734, RMSEA = 0.80, PCLOSE = 0.000, PGFI = 0.654, NFI = 0.731, CFI = 0.823, RMR = 0.158. These indicated that the original model needed to be respecified to fit better with the sample data. The following modifications were made to improve the model:

- The initial estimates based on all 29 items showed that item 9 and 15 had poor square multiple correlations (0.12 for item 9, and 0.08 for item 15), as well as low regression weights (0.29 for regression of the product factor to item 15, and 0.35 for regression of the market factor to item 9). Both items were thus deleted.
- By examining the error variances, item 21, 13, 12, 18, and 11 were eliminated. The error variance of item 21 was 1.49, 1.48 for item 13, 2.05 for item 12, 1.18 for item 18, and 1.44 for item 11. Eliminating these items did not affect other items significantly, while the overall goodness-of-fit indices improved. Some items with large error variances were retained, because deleting them would have caused other items to lose effect on the component factors and the overall model fit.
- Modification indices showed that item 5 and 6 had large error covariance (38.647). Further assessment of the squared multiple correlations and regression weights of both items showed that item 6 had less effect in the construct than item 5. The regression weight for item 6 was 0.74, and 0.78 for item 5; the squared multiple correlation was 0.55 for item 6, and 0.60 for item 5.
- Item 23 of the behavioural innovativeness factor cross-loaded onto other factors, namely the product factor (MI = 5.467), the market factor (MI = 12.470), and the process factor (MI = 5.198). To avoid cross loading, item 23 was deleted.
- Item 4 and item 14 had low squared multiple correlations (i.e. 0.18 for both items), and relatively low regression weights (i.e. 0.42 for both). However, removing item 4 would have caused other items to lose their overall effects on the component factor. The same happened to item 14. Removing either or both items would only improve the model fit indices to a very small extent. Additionally, eliminating item 4 would have weakened the reliability value of the market innovativeness component from 0.6848 to 0.6639. Removing item 14 would have also reduced the reliability of the strategic innovativeness factor from 0.6311 to 0.6237. For the above reasons, both item 4 and item 14 were retained in the construct.

Following the above steps, nine items were eliminated in total. The modified first-order confirmatory factor analysis model fit indices are: $x^2 = 252.453$, $x^2/\text{df} = 1.578$, df = 160, GFI = 0.897, AGFI = 0.864, RMSEA = 0.052, PCLOSE = 0.372, PGFI = 0.683, NFI = 0.874, CFI = 0.949, RMR = 0.108. The respecified model fits the sample data better. From Table III, it is easy to see that the regression weights of all variables loading onto their respective factors are

Table III Loadings of the first-order confirmatory factor analysis

Variables	R^2	Standard first-order loading[a] Behavioural		Product		Process		Market		Strategic	
IN20	0.41	0.64[c]									
IN25	0.58	0.76	(9.479)								
IN26	0.78	0.88	(10.563)								
IN27	0.83	0.91	(10.770)								
Behavioural[b]		–		*0.53*		*0.76*		*0.62*		*0.83*	
IN05	0.57			0.75[c]							
IN01	0.83			0.91	(13.597)						
IN02	0.74			0.86	(12.875)						
IN07	0.33			0.57	(8.270)						
Product[c]				–		*0.66*		*0.88*		*0.70*	
IN16	0.50					0.71[c]					
IN19	0.29					0.54	(6.812)				
IN29	0.40					0.63	(7.851)				
IN17	0.32					0.57	(7.134)				
Process[c]						–		*0.69*		*0.74*	
IN08	0.42							0.65[c]			
IN03	0.32							0.56	(7.025)		
IN10	0.54							0.74	(8.705)		
IN04	0.18							0.42	(5.409)		
Market[c]								–		*0.70*	
IN14	0.18									0.42[c]	
IN22	0.32									0.57	(4.993)
IN24	0.34									0.58	(5.045)
IN28	0.40									0.63	(5.220)
Strategic[c]										–	

Notes: [a] Standard first-order loading is the standard regression weight of the individual variables' loading on to one of the component factors. Figures in parentheses are critical ratios from the unstandardised solutions; [b] Standard first-order loading for component factors (i.e. behavioural innovativeness, product innovativeness, process innovativeness, market innovativeness, and strategic innovativeness) is the covariance between any two of these component factors; [c] The critical ratio is not available, because the regression weight of the first variable of each component factor is fixed at 1; x^2 = 252.453, x^2/df = 1.578, df = 160, GFI = 0.897, RMSEA = 0.052, PCLOSE = 0.372, PGFI = 0.683, NFI = 0.874, CFI = 0.949, RMR = 0.108, AGFI = 0.864

between 0.42 and 0.91, with all critical ratios above 1.96 (which means that all the regressions are statistically significant at the 95 per cent confidence level).

Second-order confirmatory factor analysis

The purpose of the second-order confirmatory factor analysis is to facilitate testing *H1* and *H3*, as well as for future adoption in structural equation modelling. As shown in Figure 1 and Table IV, all the first-order five factors load very well onto the second-order organisational innovativeness construct. The regression weights are very close and range from 0.77 to 0.89, with all critical ratios above 1.96. The model fit indices show similar results as the first-order confirmatory factor analysis: $x^2 = 306.036$, $x^2/\text{df} = 1.855$, df = 165, GFI = 0.873, RMSEA = 0.63, PCLOSE = 0.025, PGFI = 0.686, NFI = 0.847, CFI = 0.922, RMR = 0.136, AGFI=0.839. The slight difference in the first-order and second-order estimations occurs due to the emergence of slightly different degrees of freedom between executing the first-order and second-order measurement models.

The above statistics show that all the 20 items converge into a single organisational innovativeness construct. The 20 items are partitioned into five component factors: behavioural innovativeness, product innovativeness, process innovativeness, market innovativeness, and strategic innovativeness. Each of the 20 items is loaded onto only one of these five factors, without any cross loading.

Nested models

The above model was tested against other competing models. Attempts were made to incorporate one general factor plus a number of component factors. From Table V, we can see that Model 5 (one general factor plus five component factors), which is validated in the previous sections, demonstrates a best fit compared to other models. All the model fit indices of Model 5 show improvement from those of other models.

Figure 1 INNOVOR – second-order confirmatory factor analysis

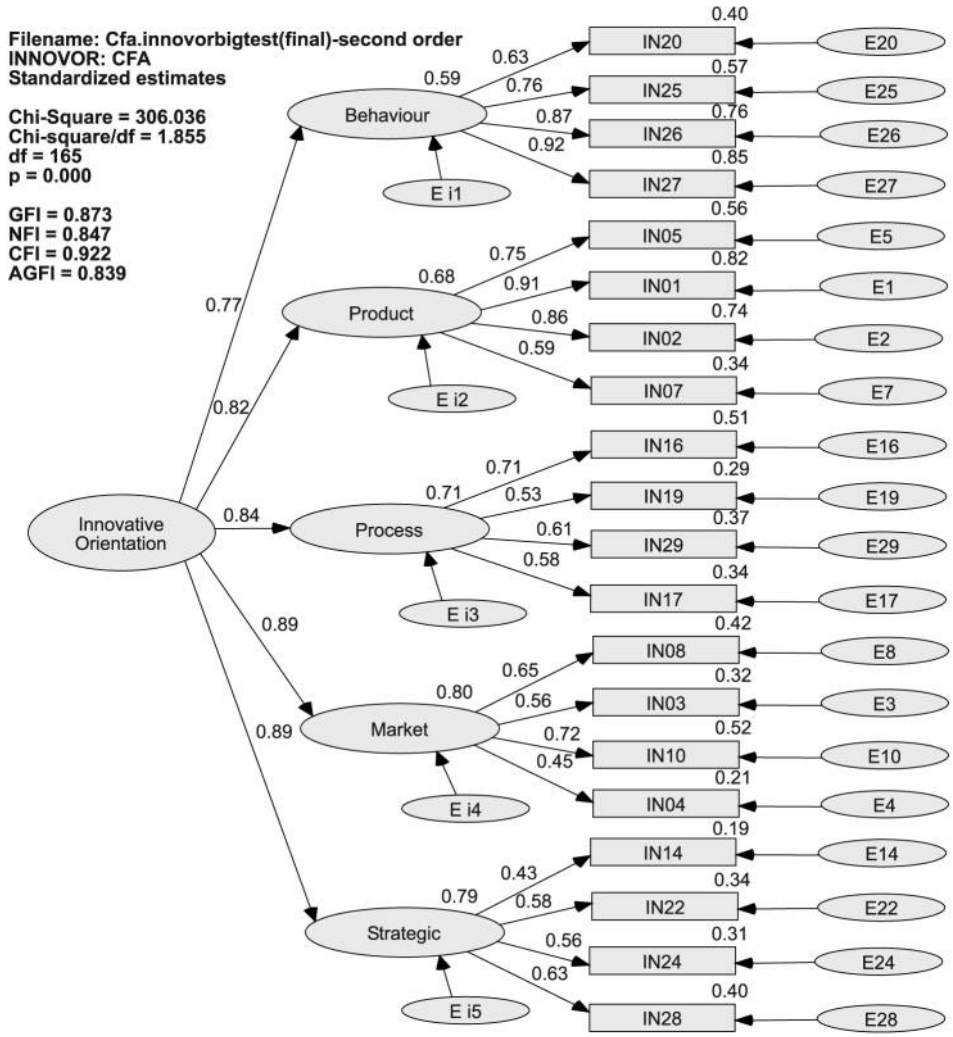

Table IV Loadings of the second-order confirmatory factor analysis

Factors	R^2	Standard second-order loading[a] Organisational innovativeness	
Behavioural innovativeness	0.59	0.77[b]	
Product innovativeness	0.68	0.82	(7.083)
Process innovativeness	0.71	0.84	(6.761)
Market innovativeness	0.80	0.89	(6.603)
Strategic innovativeness	0.79	0.89	(4.906)

Notes: [a] Standard second-order loading is the standard regression weight of each of the first-order factors' loading on to the overall organisational innovativeness construct. Figures in parentheses are critical ratios from the unstandardised solutions; [b] The critical ratio is not available, because the regression weight of the first component factor (i.e. organisational innovativeness → behavioural innovativeness) is fixed at 1; $x^2 = 306.036$, x^2/df = 1.855, df = 165, GFI = 0.873, RMSEA = 0.63, PCLOSE = 0.025, PGFI = 0.686, NFI = 0.847, CFI = 0.922, RMR = 0.136, AGFI = 0.839

Validity and reliability

Efforts were made to maximise the validity and reliability of the organisational innovativeness construct. Techniques used include:

- Multi-items were used to construct the measurement.
- When available and appropriate, existing measurement items that had been empirically tested were utilised.
- New items were built on theories. each item was checked against the relevant content domain for the construct to maximise face and content validity.
- Confirmatory factor analysis was employed to verify that each item loads onto one single component factor of the construct without any cross loading onto other component factors. All the five components converge into one general factor – organisational innovativeness.
- Our chosen measurement model for organisational innovativeness (Model 5 in

Table V Results of nested model

Model	Description	x^2	df	x^2/df	GFI	RMR	RMSEA	PCLOSE	CFI	NFI
1	One general factor	1,206.46	324	3.724	0.644	0.190	0.113	0.000	0.672	0.603
2	One general factor + two component factors	916.068	324	2.827	0.743	0.228	0.093	0.000	0.780	0.698
3	One general factor + three component factors	577.918	249	2.321	0.817	0.151	0.079	0.000	0.862	0.783
4	One general factor + four component factors	730.483	320	2.283	0.798	0.152	0.078	0.000	0.847	0.760
5	One general factor + five component factors	306.036	165	1.855	0.873	0.136	0.630	0.025	0.922	0.847
6	One general factor + six component factors	683.246	293	2.332	0.806	0.161	0.079	0.000	0.850	0.767

Note: The above reported are second-order model fit indices

Table V) was also compared against other models, and proved best fit among all; thus, the convergent validity of the construct is supported.

To test the internal consistency reliability, Cronbach's coefficient alpha test was performed. The item-total correlations are greater than 0.3. The alpha value of each of the five component factors as shown in Table VI are equal to or greater than 0.60, the acceptance level as suggested by Price and Mueller (1986). The overall alpha value of 20 items is 0.9091. The reliability of the organisational innovativeness is supported.

Discussion and conclusion

The organisational innovativeness construct developed in this paper takes a step forward towards effectively measuring an organisation's innovative capability. The significance is primarily three-fold. First, departing from the majority of existing research that focuses on one or two aspects of innovation, the proposed organisational innovativeness construct captures the principal elements of innovative capability, and thus depicts an organisation's overall ability to product innovative outcomes. Second, the proposed construct incorporates an organisation's strategic

Table VI Results of the reliability test

Components	Items	Item-total correlation (I)	Alpha if item deleted (I)	Alpha of components	Item-total correlation (II)	Alpha if item deleted (II)
Behaviour innovativeness	IN20	0.5965	0.8878	0.8736	0.5693	0.9043
	IN25	0.7177	0.8426		0.5508	0.9048
	IN26	0.7748	0.8197		0.7317	0.9002
	IN27	0.8346	0.7936		0.7194	0.9004
Product innovativeness	IN05	0.7081	0.8158	0.8575	0.6139	0.9032
	IN01	0.7963	0.7765		0.7183	0.9002
	IN02	0.7660	0.7921		0.6842	0.9015
	IN07	0.5503	0.8750		0.5217	0.9055
Process innovativeness	IN16	0.6032	0.5491	0.6935	0.5784	0.9044
	IN19	0.4291	0.6652		0.4460	0.9073
	IN29	0.4733	0.6316		0.5090	0.9058
	IN17	0.4183	0.6642		0.5054	0.9059
Market innovativeness	IN08	0.5176	0.5969	0.6848	0.5450	0.9050
	IN03	0.4351	0.6398		0.4901	0.9063
	IN10	0.5385	0.5706		0.5968	0.9037
	IN04	0.3991	0.6639		0.3612	0.9099
Strategic innovativeness	IN14	0.3280	0.6237	0.6311	0.3752	0.9096
	IN22	0.4535	0.5308		0.4901	0.9064
	IN24	0.4519	0.5342		0.4820	0.9065
	IN28	0.4177	0.5566		0.5636	0.9045

Notes: The scale used is a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The "item-total correlation (I)" is the correlation of a particular item and the component factor on to which it loads. The "alpha if item deleted (I)" is the alpha value of the component on to which a particular item loads when this item is deleted. The "item-total correlation (II)" is the correlation of a particular item and the overall construct. The "alpha if item deleted (II)" is the alpha value of the overall construct when a particular item is deleted

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orientation as a prime factor of innovation capability. This essentially means that the construct assesses the potential innovative capability and demonstrates a future orientation. This sets it apart from most of the existing constructs that measure an organisation's innovation activities from a current and static viewpoint. Another feature of our construct is a demarcation of a general organisational innovativeness factor and five component factors. This gives a thorough assessment of an organisation's innovative capability. In spite of these contributions, several theoretical and methodological issues regarding application of the measurement construct warrant explication.

Theoretical issues

More explicitly, the advantage of using a comprehensive organisational innovativeness construct over a construct of a certain dimension of innovation can be demonstrated from three aspects. First, organisational innovativeness is represented through certain traits such as newness and novelty etc., and can be easily quantified in terms of to what degree or extent that organisations are innovative, rather than simply dividing them as either innovative or not (Rothwell and Zegveld, 1982). Second, organisational innovativeness, as a trait, can be constructed to cover various key aspects of innovation. It is more likely to build up a multidimensional measurement, which is more reliable for measuring overall innovativeness rather than examining the innovative nature of an organisation through one or two aspects of innovation. Finally, organisational innovativeness measures capabilities of an organisation and indicates the propensity of the organisation to introduce new products to the market, or open up new markets. Measuring overall innovativeness is not only about measuring new product developed or new market opportunities, but also prescribes the underlying elements of innovation outcomes, i.e. behavioural innovativeness, process innovativeness, and strategic innovative orientation.

A counter argument would be if an overall measurement for organisational innovativeness is beneficial. Under certain circumstances, a specific dimension of an organisation's innovative capability perhaps gives a more insightful understanding or statistically more significant findings. For example, the product innovativeness indicates a strong prediction of successful new product development (Zirger, 1997; Sethi *et al.*, 2001). Indeed, our five component factors offer the opportunities to utilise each of them independently. The validity and reliability of each component factor was tested and confirmed in the analysis section.

Methodological issues

Strictly speaking, our initial hypotheses were rejected. The hypotheses were revised to discern 20 items instead of 29 items. The five component factors remain the same. The modified three hypotheses were all accepted based on the overall assessment of model fit indices. The respecified measurement model from both first-order and second-order confirmatory analysis demonstrates a good fit with the sample data, as illustrated in Tables III and IV, and Figure 1.

The development and validation of scales requires retests and replications in a systematic manner (Churchill, 1979; Gerbing and Anderson, 1988). Our organisational innovativeness construct is the first test and need to be subject to further research. More items may be added to the construct and retested for validation. Additionally, although the convergent validity of the construct is confirmed in this study, the discriminant validity is not part of this research. For future studies when applying this construct, it is worthwhile to test its discriminant validity. Another recommendation would be to test the causal relationships between organisational innovativeness and other organisational parameters. By doing this, predicative validity can be further tested.

In conclusion, the objective of this study was to develop a measurement for organisational innovativeness. Although additional work is needed, particularly in the methodological domain, the results reported are promising. The findings provide a basic framework and, combined with the above recommendations, provide a direction for future research.

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