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**REVISITING THE INTELLECTUAL WEALTH OF NATIONS:
OPERATIONALISING THE FLOW OF INNOVATION.**

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Abstract

In this paper, we develop a conceptual framework for the measurement of the intellectual wealth of nations. We argue that rather than persist with the outcomes-based indicators of intellectual assets favoured by the World Bank and United Nations, there is a process-based approach that may be tied to the value of innovation. Specifically, this model comprises the key innovation life-cycle processes of value creation, value indication, and value protection aspects of intellectual capital. We posit that the above three components of our model drive the national culture of innovation and thereby contribute to development and growth. The empirical results of operationalising the wealth of nations suggests that such an approach is valid and feasible. We conclude with an agenda for research that adds to the discourse on the theory of knowledge policy.

Keywords: information society; knowledge assets; innovation; growth and development.

INTRODUCTION AND SCOPE OF RESEARCH

Scholarly research on National Intellectual Capital (NIC) or alternatively the Intellectual Wealth of Nations (IWN) agrees that it is intangible and difficult to identify, let alone measure (cf. Stewart 2001; Hunter et al. 2005; Hamilton 2006; World Bank 2010). In an earlier article on the intellectual wealth of nations (Sharma et al, 2012), the academic basis was established to identify the key roles of innovation in relation to the intellectual capital of the nation. In this paper, this idea is now developed into an analytic framework and process model. It is followed by the identification of useful measures to estimate the intellectual capital of a nation from an innovation lens.

Specifically, there are two research objectives:

1. To construct a conceptual framework and analytical model to articulate the key components of the intellectual wealth of nations and connect these key roles to the growth of the intellectual capital of a nation.
2. From the model, identify suitable measures as proxies for the growth of intellectual capital particularly with respect to the role of innovation.

The remainder of this paper is organised as follows. The next section articulates the conceptual basis for what we propose as the CIP model for analysing the intellectual wealth of nations. Following this, we develop a series of analytical models for each of the three components of our proposed CIP framework. Proxy measures for Value Creation, Value Identification and Value Protection are identified and data is obtained from reputable databases. The section on “Results and Discussion” applies the data in order to test the validity of the analytical modelling. The paper concludes with a statement of key findings.

CONCEPTUAL FRAMEWORK

From a review of the scholarly literature on NIC, a Creator, Indicator and Protector (CIP) framework showing the three key roles of innovation in the intellectual capital of a nation may be established. We argue that rather than adopting the outcome-based approach of the World Bank (cf 2010) which quantifies NIC through the use of a basket of indicators, a process-based approach which quantifies the desired actions of extracting value from knowledge assets would be a novel contribution to the

theory of NIC policy. Innovation is the processes of creating and then applying knowledge in order to obtain performance advantages (Teece, 1986). Hence a framework based on the life-cycle of innovation is proposed. A basic analytical model is then constructed from this framework to model the relationships between these roles of innovation and provide a useful tool to estimate the intellectual capital growth arising from sustained innovation activity. The following details the construction of the framework and model.

Theoretical Assumptions

The first task is to determine a working definition of innovation and define the classification of intellectual capital. The key focus is on knowledge, where it resides in, how it is processed and what becomes of the new knowledge created.

For innovation, the second approach of considering innovation in terms of its knowledge and related resources that contains this knowledge will be used rather than an output perspective (Asimakou, 2008) to focus on the intangible raw materials of innovation. The definition of innovation suggested by O'Sullivan and Dooley (2009, p. 5) will be used and adapted into the context of a nation in the following manner:

Innovation is the process of applying the national intellectual capital to make changes, large or small, to products, processes, and services that result in the creation of new tangible value and also contributing to the growth of intellectual capital of the nation.

By this definition, any process or activity that fits into the above description shall be deemed as innovation. The purpose of this working definition is to dispel the common assumption that innovation only takes place in certain departments of organisations such as in certain research institutions of a nation. Recalling the seven levels of work (Kinston & Rowbottom, 1989), innovation can be inferred to be taking place at all levels of work in a nation. Therefore, even activities such as productivity shall be considered as innovation in this paper.

In terms of intellectual capital, the simple and commonly used classification of human capital (HC), structural capital (SC) and relational capital (RC) previously described in the literature review will be used in this research.

Model Overview

From the working definition and the contents from the literature review, an initial simple broad framework is constructed to connection the following concept of innovation, its roles and its end state. This paper takes the position that the various processes of innovation form the starting foundational base of knowledge from which new intellectual capital grows from. The value that is added to the intellectual capital comes from the key roles performed by innovation.

The first key role is that of value creation from the immediate outcomes during the process of innovation. The second key role is that of a value indicator to external agents on the level of innovativeness and intangible wealth of the nation. The third key role is that of a value protector in keeping the intellectual capital of the nation relevant to the changing environment through effects arising from reinforcement and codification. Figure 1 is the initial simple framework connecting the ends, ways and means.

Figure 1: General Intellectual Capital Growth Framework

I) Value Creation (VC)

The first key role is a straight forward one that arises from the fact that innovation creates tangible value but behind the tangible value is new knowledge that flows back to the knowledge stock, similar to Romer (2003) description of knowledge building more knowledge. This is also briefly described in the CIMC model by Al-Ali

Means

(2003) and in greater detail by Bontis (2004) in his key proposition for the creation of an intellectual capital index for nations. In the development of a definition for innovation O'Sullivan and Dooley (2009) also describes this notion of value creation.

Using the perspective of new knowledge creation, Nonaka (1994) describes this in his SECI model where knowledge creation in an organisation occurs in a continuous cycle. Each of the four stages from socialisation to internalisation captures this idea of new value added back to the knowledge base of the organisation be it in tacit or explicit forms, in the individual or as a group. At the nation level, the value of these new knowledge creations can be at diffused at different levels (Kinston & Rowbottom, 1989) from basic improvements concerning day to day activities to large changes in the national landscape such as setting up of a national research institute to support economic growth for decades to come.

A logical analysis reveals the following: a new product, process or service is result of a combination or at least one type of intangibles with tangible resources. SC and RC alone will not create value by itself so the starting intangible resource will have to be HC as stated by Stewart (2001) who regarded HC as the “source of innovation and renewal” (p.76). At the base case, a person using pure thought when innovating uses only HC but in general, during the innovation process, a combination of HC, SC and RC will be used. This possible combination between the starting intangible(s) with other intangibles and tangibles is the new knowledge itself and hence minimally creates new HC amongst the people involved. During the process of innovation, there will be new processes or techniques that are also used be it from established research (internal or externally acquired knowledge) or from serendipity resulting in the initial creation of SC. For innovation that involved customers or suppliers, new RC may also be formed during positive interactions and outcomes.

Even in the situation of a failed outcome, new knowledge is also created in terms of the factors and issues attributed to the failure that can be learned and documented for future reference. The value of HC increases because now you know what not to do the next time. This is an additional to the overall knowledge stock of the organisation. There may be processes written to prevent the mistakes that will be made and hence new SC. The new level of knowledge can be described simply as the sum of the knowledge of success plus knowledge of failures. For knowledge of success, such

new knowledge can be susceptible to subsequent diffusion to the wider market through the SLC cycle depending on the actions of the organisation as described by Boisot (1998), which thus will represent a further increase in overall knowledge stock when considered at the whole of nation level. This is especially during the S-learning process in coming out with radical innovation (Boisot, 1998).

It is important to highlight at this juncture that the first key role described under this section is about the immediate value creation that results from the innovation process. It is focused on the level of knowledge stock, particularly knowledge found in HC and SC. Therefore, the term “value creation” is not to be taken in its broad literal sense because in the subsequent two sections, value creation will also be articulated from the other two key roles though from a different angle. It is understood that innovation creates value and in the focus of this research, the value back to the intangible raw materials. These three key roles that will be articulated are meant to provide further granularity in terms of exactly how does it do so, with each having a common theme of value creation.

II) Value Indication (VI)

The second key role performed by innovation to the intellectual capital of the nation is that of an indicator. Innovation is considered the process that manifests the value of the intellectual capital of a nation into tangible forms that allows external agents to appreciate the value of intangibles in the nation.

The above occurs at the commercialisation (Al-Ali, 2003) or impacting (Boisot, 1998) phase in terms of the stages of innovation. This is also where agents interact with the new outcomes that will lead to a dominant design (Jacobides, Knudsen, & Augier, 2006; Teece, 1986). From the usefulness of the innovation, an impression and appreciation of how innovative a nation’s intellectual capital is formed. This notion of value indication is also described by Bontis (2004) under his human capital development research where in the long run, the nation is able to commercialise the knowledge embedded in its people and processes in local or global economies, thereby establishing a cycle and reaping economic returns.

Innovation outcomes also include codified knowledge such as scientific discoveries or patents that can be exported. The subsequent value added back to the

knowledge base of the nation is argued to be mainly in the domain of reputation, i.e. relational capital. For example, a continuous stream of significant discoveries from a research institute followed by effective actualisation into the market will enhance the reputation of nation. This in turn encourages external agents to use the outcomes of the nation's innovation such as paying royalties for their patents. Innovative ideas to reduce the bureaucracy of doing business in a nation coupled with other supporting factors like rule of the law will also enhance the reputation of a nation and thus increase its relational capital amongst external agents.

Reputation outcomes also manifests in the realm of tourism. Innovative outcomes such as architecture, efficiency of transport, culture displayed by citizens and other innovative services provided during the tourist's course of stay will increase the relational capital of the nation. When these tourists go back to their home countries, the innovative knowledge of the nation is further diffused when it is shared with other external agents.

However, subsequent actions of external agents are not solely influenced by reputation alone. Decisions such as investment decisions in starting a new company or going into a foreign alliance are also subjected to other factors such as economic demand and supply. Therefore, it is possible that external agents appreciate the reputation of a nation from its innovative outcomes but other reasons such as lack of funding or a global economic crisis can result in a negative decision to invest in that country. Strong relational capital only represents the potential for future actions by external agents and not the direct reason to act.

In summary, this second role articulated in this section is focused on the indication effect to external agents during the process of innovation. It is also about value creation though from a different perspective as compared to the previous role of VC.

III) Value Protection (VP)

The third key role is that of protecting the value of intellectual capital in a nation. The first reason arises from the early stages of the innovation process, namely in the idea generation (Al-Ali, 2003) and scanning stages (Boisot, 1998). Protection here refers to keeping the intellectual capital of a nation continuously relevant to the

changing environment, i.e. protecting it from becoming irrelevant or becoming less useful. The early stages of innovation involve some sort of a scanning process that searches the horizon on information about opportunities and threats of which ideas are generated to attempt to address these opportunities and threats. Therefore, in conducting the scanning stage during innovation, an organisation increases its chances in detecting significant opportunities such as green-fields (Al-Ali, 2003) or threats such as black/grey swans (CEDARS, 2009) that can may impact the nation in the short or long term. Innovation can thus be treated as a horizon scanning tool or also regarded as a competency of innovation management (under the CIMC model) that is required to anticipate and respond effectively to changes in the environment (Al-Ali, 2003).

In disruptive innovation, if an organisation does not keep up with new technology or new standards that may be suddenly imposed onto the organisation by the environment, then the organisation is likely to be rendered less competitive and along with it its intangibles which are not able to keep up with the new knowledge creation to compete with these disruptive innovation. Such intangibles that cannot produce outcomes desired by the current environment are as good as having no value at all even though the physical substrate embedding the intangible exists. Therefore, in the environment of disruptive innovation it is about gaining early awareness of the environment drivers and managing the subsequent effects (Jacobides et al., 2006). This can be done through acquiring new knowledge in the form of new HC from new hires, SC from new systems purchased or RC from new joint ventures to keep the organisation's intangible capital relevant to the changing environment.

Likewise, at the nation level, the same applies to the nation's institutions and agencies in keeping the country competitive in response to the various developments around the world, such as the impact of any man made or natural global level crisis that will cause a shock to the knowledge eco-system of the nation. For innovation that introduces radically new products that in turns result in a change in the market's architecture, new standards are establish which leads to new complementary assets required to support this innovation in the country (Jacobides et al., 2006; Teece, 1986). This also represents a further increase in SC of the nation in time.

The second reason behind innovation protecting the intellectual capital of a nation comes from the reinforcing effects and codification effects. Reinforcing effects

refers to the R&D investments that usually accompany innovation efforts. These investments manifests itself to benefit the intellectual capital eventually in providing the resources that allow the organisation to reinforce its HC and SC with new and the latest resources (e.g. new hires and additional training) that in turn sustains the new knowledge creation (Bismuth & Tojo, 2008).

Codification builds up a critical mass of explicit knowledge, allows permanence and promotes diffusion of this knowledge to become public knowledge (Boisot, 1998; Kahin & Foray, 2006) than if it was left purely in its tacit form, where face to face interaction needs to be mediated with extra effort. With an additional explicit form, the total knowledge stock (HC + SC) is definitely more than if it was just in the heads of the people (HC only). Also, in an explicit form, the knowledge can be protected from the effects of time and unauthorised access by putting it into a secured electronic data repository. Left on its own in a person's head, knowledge can be forgotten with time when it is not recalled often for use.

In summary, this third role articulated in this section is focused on the reinforcing and codification effects on knowledge during the sustained efforts of innovation after the initial innovation process. It is also about value creation though from a different perspective as compared to the previous roles described in for VC and VI respectively. It is also to be highlighted that VP creates value primarily in HC and SC similar to the role of VC but in a different time perspective where value comes after the initial effort if the innovation effort is sustained.

CIP Framework

With a synthesis of the above discussion, we meet the first research objective of formulating a model that describes the intellectual wealth of nations. Specifically, the three key roles performed by innovation of Value Creation (VC), Value Indicator (VI) and Value Protection (VP) represent the three different facets of intellectual wealth.

Figure 2: Linking the CIP Components.

The CIP framework is shown in Figure 2 to provide a visual illustration. Innovation produces new products, services and processes that hold new knowledge from the new combinations of intangible(s) with both the other intangibles and tangibles. This result in the immediate outcome of an increase in knowledge stock in the three types of intellectual capital, hence the value creator role to its raw materials. From the tangible outputs, the immediate effect is the manifestation of the value of these intangible raw materials, hence the value indicator role as external agents begin to appreciate the intellectual capital of an organisation or nation. Sustained innovation leads to reinforcing actions and the amassing of the codification of knowledge. This keeps the intellectual capital relevant to the changing environment and increases its longevity, hence the value protector role against negative effects brought about by the changing environment such as disruptive innovation that is brought about by the competition or other technological advances that arises from different time periods of the innovation processes.

MODELLING INTELLECTUAL CAPITAL GROWTH

From the framework a basic analytical model is constructed to represent intellectual capital growth that comes from sustained innovation activity. This model seeks to establish a relationship of the current value of intellectual capital with respect to the initial value of intellectual capital from the initial innovation effort.

The intellectual capital created from innovation can be said to be the sum of the three types of intangible capital. This gives the starting point of:

$$IW_i = HC + SC + RC$$

From the CIP model, the first role of VC represents the initial creation of value. This value will be used as the base case denoted by:

$$V_c = HC_1 + SC_1 + RC_1$$

Sustained innovation leads to the second role of VI that mainly contributes to RC. This can be represented by:

$$V_i = F(t) \times t \times RC_1 \text{ where } t \geq 0$$

V_i is the value of additional RC at a particular time, t , that is created after a period of sustained innovation. $F(t)$ represents the multiplier effect per unit time based on the initial value, RC_1 , that arises from sustain VI effects. For the purpose of simplicity, assume a linear effect that is proxied by the constant, k_1 , which has a maximum value of α which denotes the realistic limit of the multiplication effect that is possible as time goes towards ∞ . The numerical value of RC_1 can be represented with respect to V_c by a constant k_2 , where $RC_1 = k_2 V_c$. Therefore, the additional RC contributed from the role of VI can be approximated by:

$$V_i \approx k_1 t \times k_2 V_c \text{ where } 0 < k_1 < \alpha, k_2 > 0$$

The third role of VP that performs reinforcing and codification roles contributes to additional HC and SC. This can be represented in a similar manner by:

$$V_p = [G(t) \times t \times HC_1] + [H(t) \times t \times SC_1] \text{ where } t \geq 0$$

$G(t)$ and $H(t)$ are the per unit time multiplier effects based on the initial values of HC and SC. Similarly as per how V_i was derived, assume the multiplier effects to be linear up to a limit and representing HC_1 and SC_1 in terms of V_c , V_p can be approximated by

$$V_p \approx k_3 t \times k_4 V_c + k_5 t \times k_6 V_c$$

$$V_p \approx t(k_3 k_4 V_c + k_5 k_6 V_c)$$

$$\text{where } 0 < k_3 < \beta, 0 < k_5 < \gamma, k_4 > 0, k_6 > 0$$

k_3 is the multiplier constant for HC while k_5 is the multiplier constant for SC. k_4 is the constant that represents HC_1 in terms of V_c and k_6 is the constant that represents SC_1 in terms of V_c .

Putting all three roles together, the value of intangibles at a particular time is the value of the initial creation plus the additional value if the innovation was sustained. This can be approximated by the following:

$$IW_i(t) \approx V_c + (V_i + V_p)$$

$$IW_i(t) \approx V_c + (k_1 t \times k_2 V_c + k_3 t \times k_4 V_c + k_5 t \times k_6 V_c)$$

$$IW_i(t) \approx V_c [1 + t(k_1 k_2 + k_3 k_4 + k_5 k_6)]$$

$$\text{Where } 0 < k_1 < \alpha, 0 < k_3 < \beta, 0 < k_5 < \gamma, k_2 > 0, k_4 > 0, k_6 > 0$$

The analytical model proposed in the above derivation is to be interpreted and used in the following way:

1. The model views the creation of value through an initial value followed by additional value if innovation was sustained. For a one time effort, then $t=0$ and the result of intellectual capital will be the only the initial value created, V_c . The variable t is a self-defined per unit time that is used to represent sustained innovation after an initial period of time when V_c is determined. For example, t can be defined as the number of years after the first year of innovation when the product was rolled out into the market. V_c in this example will represent the sum of the values of HC, RC and SC estimated at end of the first year.
2. If innovation effort was sustained (e.g. continuous flow of new products/services/solutions over time) the additional value can be estimated by approximating values of the constants (k_1 to k_6) using values at different points in time. This will ultimately provide a coefficient that shows many times had intangibles grew when reference from the initial effort. Using the example of a firm, brand equity calculated from other methodologies can be used to approximate the value of RC. If the brand equity of a company valued at \$100 million is 20%, then RC_1 can be proxy at \$20 million while V_c as a starting point can be the difference between the market value and book value. Using two different book values of a company's valuation at different points in time, k_1 and k_2 can be determined. Likewise, to find a proxy of SC using suitable components such as patents accounting for a percentage of the total valuation of the firm. This percentage can thus be attributed to SC. The value of HC can then be determined as a residue and k_3 to k_6 can be estimated.

3. The utility of this model is on the comparative analysis between the entities in the model. It is not meant to be used to find an exact value of intellectual capital or any of its entities in the model. The relative comparison and trending of intellectual capital growth, IW_i , and the relative comparison of k_1 , k_2 and k_3 over time is meant to reflect the difference in contribution to the total intellectual capital with respect to the innovation strategy that was adopted. For example, k_1 that is found to be consistently larger than k_2 and k_3 represent a strong marketing and branding component of the innovation strategy that is adding more intangible value by RC as compared to the R&D effort's contribution to HC and SC. By tracking the relative comparison of contribution over time, the organisation can adjust its innovation strategy based on its desired objectives of intangibles creation. In the above example, realising that branding and marketing is contributing more to intangibles may not be the desired objective of the organisation because the organisation considers strong growth in HC and SC to be more important in the long term as part of its blue ocean strategy to find more green fields.

ANALYSIS OF MEASUREMENTS

From the three key roles of innovation, suitable measures are identified to proxy for their growth to achieve the third objective of this research. A research hypothesis was formulated for each of the VC, VI and VP roles:

H_{VC} : “An increase in the level of innovation will lead to an increase in the creation of IC”. This is to establish the foundation in confirming the general notion of a positive correlation between sustained innovation and IC. The respective country's value of intangibles measured by the World Bank is compared against its innovation trend.

H_{VI} : “An increase in innovation makes the measureable value of IC more visible and will increase the actions taken to make use of the innovation outcome”. This is to discern the actions that are most often taken (versus actions that may be distorted by other external factors) when an agent starts to appreciate the innovativeness and IC of a nation. Selected measures are compared against innovation trend.

H_{VP} : “An increase in innovation results in the protection of intangibles and an increase in competitiveness, effectiveness, sustainability and technological superiority”. The

purpose of this hypothesis is to discern the extent of the effects from innovation in relation to macro-economic measures of a country. Selected measures are compared against innovation trend.

The analysis that follows concerns primarily with the second objective of this research. Specifically, to identify suitable measures as proxies for the growth of intellectual capital particularly with respect to the role of innovation. The following sections shall explain the relevant hypothesis, scope and choice of data that are used in order to identify suitable measures to proxy for the overall as well as specific aspects of intellectual capital growth.

Data Selection Procedures

The following are data categories that should be common across the three hypotheses in order to maintain some form of consistency and a common platform to gain useful insights for correlation of outcomes that were unexpected:

- a. Number and choice of countries.
- b. Time period of analysis.
- c. Data for determining innovation trend.

The availability of the desired data will also influence the choice to be made depending on the context. In this research, data that is available to indicate the trend of innovation and data indicating the value of intangibles are two key limiting factors.

In the former, the Global Innovation Index (GII) (INSEAD, n.d.) is the desired comprehensive indicator to show the innovation trend because its construction is considered by the author to be comprehensive. However, this index only started in the year 2007 with yearly updates only from the year 2009 onwards. Therefore, the desired ten years' worth of trending data is not available. In addition, the taxonomy to determine the innovation scores of the GII evolved gradually through the years and more countries were added to the GII report as well.

In the latter, the data showing the value of nations' intangibles (World Bank, 2010) that is important to the first hypothesis, is available at five years intervals starting from the year 1995 and up to the year 2005 only. This created the dilemma on having to construct a proxy of innovation trend between 1995 and 2005 should this

time period be used for any analysis. Such a proxy for innovation trend will also inevitably use measures that are to be compared against innovation trend under the second and third hypotheses' construct. For example, R&D expenditure is an outcome examined under the third hypothesis. Therefore, if the second and third hypotheses are to be analysed in the time period of the year 1995 to 2005, there will be measure(s) used to proxy both the innovation trend and in the outcome that is to be correlated, thus introducing significant bias in the correlation.

Balancing the issues of data availability and potential of biasness, it was decided that the first hypothesis will be analysed in the time period of the year 1995 to 2005 due to the unavailability of the most important data (value of intangibles) from 2006 onwards. These countries, in alphabetical order, are:

Australia	Japan
Austria	Kuwait
Belgium	Luxembourg
Canada	Malaysia
China	Netherlands
Denmark	New Zealand
Finland	Norway
France	Singapore
Germany	South Korea
Hong Kong	Spain
Iceland	Sweden
India	Switzerland
Ireland	UAE
Israel	United Kingdom
Italy	United States

The second and third hypotheses will be analysed from the year 2007 to 2012 to avoid biasness between innovation trend and correlated measures. The top thirty countries under the GII report of the year 2007 will be used throughout the three hypotheses to maintain consistency and minimise the effects of additional countries that were added into the GII from the year 2009 onwards.

Proxy Measures For Value Creator

All the data used for the first hypothesis is drawn from the World Bank's database. In this hypothesis, there are two key trends that are analysed, the trend of innovation (to be proxied) and the trend of a nation's value of intangibles estimated by

the World Bank. The simple average of each type of data over the period of time is calculated and compared with the first data point for the assessment of whether there has been an increasing, decreasing or constant trend.

The innovation trend is proxied by using Science and Technology measures from the World Bank's online database (World Bank, n.d.) from the year 1996 to 2005. Two output related measures and two input related measures were chosen in order not to bias towards either of the two types of measure:

1. *High technology exports*: Output related measure.
2. *Patent applications, residents*: Output related measure.
3. *R&D expenditure*: Input related measure
4. *Royalty and license fees, payments*: Input related measure.

If the majority (4/4 or 3/4) of the measures are of increasing trend, then it is deemed that the nation's level of innovation has increased. This is coded in green in the table given in Appendix A. An equal outcome (2/4) will mean innovation levels are constant and minimally sustained. This is coded in yellow in Appendix A. A low outcome is when few (0 or 1) of the (4) measures have increased. In other words, most have decreased. This is colour coded in red in Appendix A. All four measures are assumed to be of equal weight for simplicity.

The value of the various nation's intangibles is drawn from the World Bank's "Wealth of Nations" dataset (World Bank, 2010) that provides an estimate of a nation's intangibles. The value of intangibles of each nation is drawn from the years of 1995, 2000 and 2005, thus giving three different data points over ten years. The overall ten year trend analysis and its two sub-components of 5 year analysis (1996-2000 and 2001-2005) will be examined.

Proxy Measures For Value Indicator

In the second hypothesis, the data is drawn from both the World Bank (World Bank, n.d.) and the GII (Dutta, INSEAD, & Caulkin, 2007; INSEAD, 2009, 2010, 2011, 2012). The innovation trend is analysed using the simple average of the normalised GII scores. The corresponding three science and technology measures were selected to compare against the innovation trend

1. *Foreign direct investment, net inflows*: An external agent appreciating the innovativeness of a nation should be taking actions to invest in the nation.
2. *Royalty and license fees, receipts*: An external agent appreciating the innovativeness of a nation should be making direct use of the new knowledge that was created. This in turn manifests in the royalty and license fees that is to be paid to the nation's creator of the new knowledge.
3. *High-technology exports*: An external agent appreciating the innovativeness of a nation should be seeking to buy and use the outcomes.

Results shown in Appendix B use the same green-yellow-red colour coding scheme as before with VC.

Proxy Measures For Value Protector

For the third hypothesis, the data is drawn from the World Bank (World Bank, n.d.), Global Competitiveness Indicator (GCI) (World Economic Forum, 2013a) and the GII (Dutta et al., 2007; INSEAD, 2009, 2010, 2011, 2012). The innovation trend is analysed using the simple average of the normalised GII scores. The following four measures were selected to compare against the innovation trend.

1. *WEF Competitive Index*: A nation effectively protecting its intellectual capital should be increasing competitive.
2. *GDP*: A nation effectively protecting its intellectual capital should be able to increase its economic growth in a sustained manner.
3. *R&D expenditure*: A nation effectively protecting its intellectual capital should be able increasing reinforcing its HC and SC.
4. *Scientific and technical journal articles*: A nation effectively protecting its intellectual capital should be increasingly codifying its new knowledge.

Summary results for VP are shown in Appendix C using the same green-yellow-red colour coding scheme.

RESULTS AND DISCUSSION

The empirical results of applying the analytic models of Value Creation, Indication and Protection as measurements for the intellectual wealth of a nation are tabulated visually, showing upward trends in green, downward trends in red, and constancy in yellow in Appendices A, B and C respectively.

In the case of VC, for the ten and each five year period analysis, UAE, Switzerland and Kuwait's results are not considered due to lack of sufficient data (only two or less measures) to estimate innovation trend. Of the remaining 27 countries, it is observed that all these countries had a sustained innovation trend (constant or increasing) and all had a positive correlation with the growth of intangibles within the overall ten year period.

In the case of VI, as data for High Technology Exports was only available up to the year 2010, its trend was compared with the innovation score trend of the GII in the same period. From the results, it is observed that only the receipt of Royalty and License Fees was most correlated with the positive innovation trend (23/25 countries). High Technology Exports was about 50% correlated (15/30 countries) while FDI inflows showed the least amount of correlation (7/30).

Finally, in the case of VP, The results of the Global Competitive Index (GCI) were surprising with less than half of the countries displaying a correlation with the innovation trend. A closer look at the composition of the GCI reveals that other than innovation, the other two sub-indexes that make up the GCI index relates to basic factors and efficiency characteristics of the nation (World Economic Forum, 2013b). These characteristics are subjected to effects by the global economic environment. For example, macroeconomic environment is one of the pillars to the factors sub-index. The significant effects of the credit crisis resulting from the Lehman brothers (2008) followed by the Euro debt crisis (2011 onwards) could have contributed to distortions to the GCI index during this period of analysis.

The results of the rest of the measures of GDP (24/30), R&D expenditure (15/18) and scientific and technical journal articles (24/30) show close correlation to innovation trend. This suggests that these measures are less sensitive to the negative effects from global crisis events. The time period of the data is short for these measures (especially for the journal articles) to establish any sort of conclusiveness.

Table 1: Wealth Statistics of Kuwait (in millions)

Country:	Year	Population	Total	Intangible	Net Foreign	Produced	Natural
Kuwait			Wealth	Capital	Assets (NFA)	Capital	Capital
	1995	1.8	739,119	272,711	95,975	119,167	251,264

	2000	2.2	831,852	222,135	118,255	121,024	370,437
% Difference Between 1995 and 2000		22	13	-19	23	2	47
	2005	2.5	827,366	-18,718	158,405	147,346	540,332
% Difference Between 2000 and 2005		16	-1	-108	34	22	46

For the first hypothesis (HVC), UAE, Switzerland and Kuwait's results are not considered due to lack of sufficient data to estimate innovation trend (two or less measures). All of the remaining 27 countries had a sustained innovation trend (constant or increasing) and a corresponding positive correlation with the growth of intangibles within the overall ten year period. Though this result is to be expected, a closer look at Kuwait's statistics in Table 1 and Malaysia in Table 2 highlighted a potential weakness in World Bank's methodology.

It is observed that resource rich countries such as Kuwait, natural capital constitutes to a large portion of its total wealth (34% in 1995 and rising up to 65% in 2005) while natural capital's absolute value is also similar or bigger than the absolute value of intangibles. Therefore, large swings in natural capital accounting (46% in the case of Kuwait) can affect the estimation of intangible capital, since intangible capital is calculated as a residue while natural capital, produced capital and NFA are calculated based on separate accounting methodologies of physical entities. This is the same case for Malaysia in the period of 1996-2000 where large increases in produced capital and natural capital resulted in a negative value of its intangibles.

Table 2: Wealth Statistics of Malaysia (in millions)

Country: Malaysia	Year	Population	Total Wealth	Intangible Capital	Net Foreign Assets (NFA)	Produced Capital	Natural Capital
	1995	20.3	1,059,364	677,638	-47,691	276,299	153,117
	2000	23	1,208,657	653,864	-41,977	380,328	216,442
% Difference Between 1995 and 2000		13	14	-4	-12	38	41
	2005	25	1,641,668	911,054	-19,008	426,444	323,176
%		10	36	39	-55	12	49

Difference Between 2000 and 2005							
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Therefore, when using the World Bank's (2012) KAM database, there is a need to keep cognisant of the variation of data of NFA, produced capital and natural capital in making conclusions about the growth of intangibles.

For the second hypothesis (H_{VI}), the correlation results show that only the receipt of Royalty and License Fees was most correlated with the positive innovation trend (23/25 countries¹). High Technology Exports was about 50% correlated (15/30 countries) while FDI inflows showed the least amount of correlation (7/30 countries). The results suggest that making use of new knowledge is the most correlated outcome from the effects of value indication from sustained innovation. External agents would tend use the knowledge versus more complex decisions of investing in the country or importing products. The barriers in using somebody else's intellectual property are not as high as compared to decisions to invest which involves more complex factors.

High technology exports measures are subjected to prevailing economic conditions effects from global events. However, the production of goods would usually be planned ahead of a certain sales forecast, which in turn is also an outcome of an organisation's horizon scanning efforts, thus mitigating the effects of global events to some extent and hence the partial correlation (50%). Due to data availability limitations (less than 5 years), the results for VI is not conclusive at this juncture. However, the current results suggest that two measures of Royalty and License Fees and Receipts and High Technology exports can be used as proxy of how well a nation is indicating its IC to external agents. However, a weighted approach should be adopted.

For the third hypothesis (H_{VP}), the results of the Global Competitive Index (GCI) were surprising with less than half of the countries displaying a correlation with the innovation trend. This is due to two other two sub-indexes that make up the GCI index which relates to basic factors and efficiency characteristics of the nation (World

¹ 5 out of 30 countries' data were not available.

Economic Forum, 2013b). These characteristics are subjected to effects by the global economic environment.

The results of the measures of GDP (24/30 countries), R&D expenditure (15/18 countries²) and scientific and technical journal articles (24/30 countries) show close correlation to innovation trend. This suggests that these measures are less sensitive to the negative effects from global crisis events. However, the time period of the data is too short to establish any sort of conclusiveness. Therefore, for scientific and technical journal articles, an additional correlation was analysed using the data from 1996-2005 because this measure was not used to estimate innovation trend. It shows a close correlation (28/29) with innovation trend. In summary, measures of GDP, R&D expenditure and scientific & technical journal articles can be used as reasonable proxies to measure the trend of protection to IC of a nation.

FINDINGS AND CONCLUSIONS

The primary objective of this research was to investigate the relationship between innovation and the intangible raw materials that are used during the process of innovation - the intellectual capital of the nation. The author argues that other than the traditional focus on tangible outcomes, nations should also focus on the effects of innovation to the growth of their intellectual capital. Having a critical mass of knowledge that is diverse and embedded in a good spread of HC, SC and RC is deemed essential for long term sustainability in meeting the challenges from the volatile globalised world. It is important to know and monitor how well you are growing your intellectual capital.

The three roles of VC, VI and VP were derived from theories and general outcomes and not based on any specific country. Therefore, the above should be indicative on the actual roles performed by innovation with respect to its raw materials. It is acknowledged that these three roles do not represent the full spectrum of the roles performed by innovation on the intellectual capital of a nation. However, they are a useful start to develop a conceptual framework.

The conceptual framework was subsequently derived from the basic principles of the three roles which in turn culminate into the CIP model depicted in Figure 2 and

² For 12 out of the 30 countries investigated data were not available.

an analytical model. These provided an easy visualisation on the different relationships of each role with the intangibles as well as appreciating the growth of intangibles through the time dimension during sustained innovation. The analytical model served two further purposes. The first was in representing the growth of intellectual capital with respect to the initial value creation through a multiplier effect governed by time and driven by a sum of coefficients. Each of the coefficients represented the individual multiplier effects on HC, SC and RC from sustained innovation.

This analytical model presented the concept in an analytical form; the concept of intellectual capital growth from sustained innovation is derived from the multiplication effect on the interaction from the different components of HC, SC and RC. Therefore, the second purpose was the potential for use in comparing the different multiplication effects of HC, SC and RC from an organisation's existing innovation strategy. Using suitable proxies and data at different time periods, the coefficients can be estimated and compared for an assessment against the desired strategy in growing the intellectual capital of the nation. This model is meant to be used as a tool for comparative analysis of trends rather than finding an exact value of a particular type of intangibles as this is meaningless because such precision does not matter at the macro-economic level.

The last objective of the research provided the utility to monitor and analyse the indication and protection effects on the intellectual capital of a nation. The measure for value creation is already covered under the current wealth of nations methodology by the World Bank though the methodology does have limitations. Nevertheless, it is still reasonably useful as long as necessary adjustment of are done due to large swings in any of the produced capital, natural capital or net foreign assets.

For value creation and protection, this research proposes a set of science and technology measures. These were found to be closely correlated with a positive innovation trend. Qualitatively, these measures were correlated using case data from the 30 recent top innovating countries. Quantitatively, these countries represent about 16% of all the 192 countries in the world (United Nations, 2006) and thus gives a decent sample size. Therefore, it is postulated these identified measures should be indicative of the indication and protection effects of innovation for societies that are knowledge intensive and knowledge reflective (Sharma & Chandrasekar, 2010).

Notwithstanding the above conclusions, this research is far from the finished product as highlighted by the various limitations. The following are suggested areas for improvement:

1. There is a need to establish consistent and reliable data that can be used to indicate the innovation trend across the different roles that are examined. It is suggested that research can be conducted to use the latest framework adopted for the GII and establish the GII scores for all the years before that for a period of at least a ten years. More rigorous modelling and statistical analysis can also be done to improve the above.
2. Further research can be done to clarify the value creation role of innovation through analysing the innovation trend of countries that had a decreasing trend of intangibles. This can establish the effect of the consumption based methodology in calculating total wealth of a nation.
3. To be able to estimate the various coefficients, independent estimates of the percentage of total wealth needs to be established. Similar to the brand equity of a firm, research into the brand equity of a nation is suggested to establish the premium of the reputation that is commanded by a nation's RC. For example, additional premium paid by investors to do business in a country compared to another country of similar characteristics.

We suggest that such a programme of research will be a significant contribution to the theory of knowledge policy which seeks to promote growth and development.

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APPENDIX A – Visual Summary of Results for Value Creation.

	Country	Ave Intangibles per capita (1995 to 2005)	1996-2000 Innovation Trend	1996-2000 Intangibles Trend	2001-2005 Innovation Trend	2001-2005 Intangibles Trend	10 year Innovation trend	10 year Intangibles Trend
1	Australia	350,309	3/4		4/4		4/4	
2	Austria	427,684	3/4		4/4		4/4	
3	Belgium	408,920	1/3		3/4		2/3	
4	Canada	385,939	4/4		3/4		4/4	
5	China	6,662	4/4		4/4		4/4	
6	Denmark	555,626	3/3		3/3		3/3	
7	Finland	394,109	4/4		3/4		4/4	
8	France	441,169	2/4		4/4		2/4	
9	Germany	413,737	2/4		3/4		3/4	
10	Hong Kong	214,557	2/4		3/4		3/4	
11	Iceland	675,291	2/4		4/4		4/4	
12	India	4,441	4/4		4/4		4/4	
13	Ireland	411,580	4/4		2/4		4/4	
14	Israel	266,651	4/4		1/4		4/4	
15	Italy	377,822	3/4		3/3		3/3	
16	Japan	364,893	3/4		3/4		4/4	
17	Kuwait	81,796	1/2		1/2		1/2	
18	Luxembourg	568,729	2/3		1/4		3/4	
19	Malaysia	32,551	3/4		4/4		4/4	
20	Netherlands	433,425	2/4		4/4		3/4	
21	New Zealand	265,728	3/4		4/4		4/4	
22	Norway	540,806	3/4		3/4		3/4	
23	Singapore	147,613	4/4		4/4		4/4	
24	South Korea	151,790	2/4		4/4		4/4	
25	Spain	297,374	4/4		4/4		4/4	
26	Sweden	466,581	4/4		3/4		3/4	
27	Switzerland	479,270	1/3		1/2		1/2	
28	UAE	112,964	0/1		1/1		1/1	
29	United Kingdom	499,841	4/4		2/4		4/4	
30	United States	562,835	4/4		3/4		4/4	

Legend:

Increase

Constant

Decrease

APPENDIX B – Visual Summary of Results for Value Indication.

	Country	Innovation Score Trend (2007- 2011)	Foreign direct investment, net inflows (BoP, current US\$) (2007-2011)	Royalty and license fees, receipts (BoP, current US\$) Trend (2007- 2011)		Innovation Score Trend (2007- 2010)	High- technology exports (current US\$) Trend (2007- 2010)
1	Australia			N.A			
2	Austria						
3	Belgium						
4	Canada						
5	China						
6	Denmark			N.A			
7	Finland						
8	France						
9	Germany						
10	Hong Kong						
11	Iceland						
12	India						
13	Ireland						
14	Israel						
15	Italy						
16	Japan						
17	Kuwait			N.A			
18	Luxembourg						
19	Malaysia						
20	Netherlands						
21	New Zealand						
22	Norway						
23	Singapore						
24	South Korea						
25	Spain						
26	Sweden						
27	Switzerland			N.A			
28	UAE			N.A			
29	United Kingdom						
30	United States						

Legend:

Increase	Constant	Decrease
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APPENDIX C – Visual Summary of Results for Value Protection. (2 Parts)

	Country	2007-2012 Innovation Score Trend	WEF Competitive Index (2007-2012) Trend		2007-2011 Innovation Score Trend	GDP (2007-2011) Trend
1	Australia					
2	Austria					
3	Belgium					
4	Canada					
5	China					
6	Denmark					
7	Finland					
8	France					
9	Germany					
10	Hong Kong					
11	Iceland					
12	India					
13	Ireland					
14	Israel					
15	Italy					
16	Japan					
17	Kuwait					
18	Luxembourg					
19	Malaysia					
20	Netherlands					
21	New Zealand					
22	Norway					
23	Singapore					
24	South Korea					
25	Spain					
26	Sweden					
27	Switzerland					
28	UAE					
29	United Kingdom					
30	United States					

	Country	Innovation Score Trend (2007-2010)	R&D expenditure (2007-2010)	High-technology exports (current US\$) Trend (2007-2010)	Innovation Score Trend (2007-2009)	Scientific and technical journal articles (2007-2009)
1	Australia		N.A			
2	Austria					
3	Belgium					
4	Canada					
5	China		N.A			
6	Denmark					
7	Finland					
8	France					
9	Germany					
10	Hong Kong					
11	Iceland		N.A			
12	India		N.A			
13	Ireland					
14	Israel					
15	Italy					
16	Japan		N.A			
17	Kuwait					
18	Luxembourg					
19	Malaysia		N.A			
20	Netherlands					
21	New Zealand		N.A			
22	Norway					
23	Singapore		N.A			
24	South Korea		N.A			
25	Spain					
26	Sweden					
27	Switzerland		N.A			
28	UAE		N.A			
29	United Kingdom					
30	United States		N.A			

Legend:

Increase

Constant

Decrease