# Internal Process Risk Management: A Proposed Conceptual Framework for Electronic Design Industry Process Gap

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***Abstract* – Risk management is a crucial element in every industry's operational supply chain as the impact of turbulence in the form of uncertainty is drastic. Many researchers have published theories and frameworks defining Supply Chain Risk Management (SCRM) as there are gaps in the application – definition gap, process gap, and methodology gap. This paper identifies the process gap in electronic design industry and proposes a modified framework adopted from Sodhi, Son and Tang (2012) to contribute in formulating a framework to define, operationalize and mitigate internal process supply chain risk management. The purpose of this paper is twofold. First, we categorize the detailed review with electronic design internal supply chain process. Second, we analyze and develop a framework with expected results upon completing the SCRM process throughout each internal process.**
***Keywords* –** *Risk management, process gap, micro risk, uncertainty, supply chain risk management*

## 1. Introduction

Risk management is a fairly new standard applied in the world of industry since the International Organization for Standardization (ISO) published a new family of standards, the ISO 31000 in the year 2009. Until then, the term risk management was merely a terminology and was not considered as a threat for any form of industry until an unforeseen event occurs. Risk is always present in the form of uncertainty in a real world condition which involves the entire process of an operation regardless of the business nature. While experiencing the uncertainty, a particular set of process or task will be subjected to potentially losing something of value. As such, it is imperative to visualize the impact of risk in practice, especially in industries such as manufacturing and construction, whereby each process in an operation is dependent to a series of designed network, known as supply chain. Within these few years, the supply chain process has evolved tremendously with much more complexity build into it. Thus, the term uncertainty has also advanced to a new term known as turbulence and vulnerability. Leading a vast group of organizations to highly invest in the supply chain design process to avoid the turbulence rather than mitigating a system to endure the risk which can be in any form and factor.

A recent massive disruption in supply chain was the explosion of the Port of Tianjin, China which occurred in August, 2015. In addition to the lives lost, many international organizations suffered loss in the form of assets, products and financially. Approximately 304 buildings, more than 12,000 new cars (ranging from Jaguar Land Rover, Volkswagen, Hyundai, Renault and Toyota) and 7,533 cargo containers were damaged to the extreme. Though this was an external factor for the affected parties, viewing it from another angle will lead to an internal factor of the ports operation management. The main root cause of this explosion was from a single container which stored dry nitrocellulose in an open environment which was exposed to heat. Thus the implication here is that the negligence or an absence in strategizing an internal control process to identify the potential impact of storing such chemicals in an open environment was overlooked. The negative effects caused by risks (whatever scale it may be) will eventually expand to impact the entire supply chain network. Significant amount of work in the area of supply chain risk management (SCRM) needs to emphasize the internal process of any operation throughout the upstream and downstream flow of a supply chain network.

By narrowing down the possible and potential root cause to internal process, a comprehensive risk management element within an organization can potentially ensure the uncertainty in supply chain network is minimized or even eliminated entirely. Theoretically, full proof risk management in a series of process has the ability to filter out the uncertainty when a product or service is handshake to the next level. This is a crucial process as the core members who form the risk management team

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has to continuously analyze, review and mitigate a smooth transition of product or service flow by formulating a 360 view of potential threats or risks that could jeopardize respective processes in any form of turbulence. An industry that has applied an internal process risk management system is the banking and insurance industry, because it deals with monetary-based services and to one of the most unpredictable sources, people. Risk management is definitely a new trend in counteracting towards possible or potential uncertainty and strategizing it effectively will lead an organization to achieve very dynamic competitive priorities with significant amount of cost and time saved with close to excellent quality earned via flexibility.

### 1.1 Risk Management in Electronic Product Design Process

Though risk management seems to be a conventional practice in the manufacturing and services industry, it certainly needs to be applied in the electronic design industry, more commonly known as original equipment manufacturer (OEM). A design industry is the key component to have a finished product launched and reaching the customer's end at the right time as the market trends spontaneously. A slack in the deliverance from the electronic design industry will certainly delay and potentially impact every subsequent process. Over the years in the electronics design industry, many design industry such as Polaroid and Kodak have lost their market share and eventually closed down due to internal failures. Because the longer the design process takes for an organization, some other strong competitors are progressing aggressively to launch their product earlier or gain a competitive advantage as first mover with its new technology. Such condition occurs due to the complexity of the internal design release process which strongly requires the element of risk management as this industry is vulnerable to many risk factors as well, such as:

- Pre-design specification documentations
- Series of documentation reviews
- Pre-product design verifications
- Final design release
- Pre-physical design verification
- Multiple design block integration and verification
- Post-physical design verifications
- Design related Engineering Change Order (ECO); if any design flaws are captured – a complex process once the physical layout is completed

Typically a new product launch consumes almost two years of design related tasks with sufficient timeline provided to the involved departments. Such a practical time frame is plotted based on best case scenarios with minimum consideration of balance scorecard of previous projects as the complexity differs. And as the time frame gets closer for deadlines, project management team will begin to probe in by initiating various concepts such as intense scrums, Get Your Actions Together (GYAT), daily updates/meetings and dungeon mode (combining the respective project owners in a centralized location to interact until the deadline period). Even with such concepts and strategies, there are strong tendencies for deadlines to slip, as various uncertainties can occur, such as – IT dependent, efficient human resources (not multitasking individual), design protocol understanding, tools stability and continuous change is pre-design. These are series of involvement from project management team to drive the respective team during project crunch time, which is obviously considered as a risk management stage to ensure the deliverables are not impacted. Simply, such issues occur when the deadlines are closer and potential for more uncertainty to appear.

## 2. Background of the Study

### 2.1 Supply Chain Risk – General Concept

Throughout the past decades, several researchers have stated a variety of definition and scope for supply chain risk as illustrated in Table 1 [1]–[4]. These definitions are applicable in various fields such as supply risk, material flow risk, product flow risk and information flow risk. Supply chain risk focuses on specific functions or part of a supply chain, supporting this paper's concept where by every internal process requires the risk management protocol to ensure every other subsequent internal and external process in the entire supply chain network operates with no or minimum risk factors. Therefore, this paper defines supply chain risk as: "the possibility and impact of uncertain micro and macro level occurrence that severely influences the internal process supply chain causing to operational, technical or strategic level failures."

| Authors | Definition of Supply Chain Risk | Scopes |
|---|---|---|
| [1] | Any risk for the information, material and product flows from original suppliers to the delivery of the final | Information, Material & Product flow risks |

| | | |
|---|---|---|
| | product for the end user | |
| [2] | The probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety | Supply Risk Only |
| [3] | The negative deviation from the expected value of a certain performance measure, resulting in negative consequences for the focal firm | General Risks |
| [4] | An individual's perception of the total potential loss associated with the disruption of supply of a particular purchased item from a particular supplier | Supply Risk Only |

Table 1. Definitions of supply chain risk stated by researchers.

**2.2 Supply Chain Risk Management – General Concept**

There are supporting definitions for SCRM by respective researchers which aligns with the Table 1 statements and concept. Table 2 describes several authors inputs in supporting the focus point of a risk management element are on specific element or in this case, internal processes. As such, this conceptual paper's framework illustrated in Figure 3 defines the type of SCRM for electronic design industry as: "an inter-department collaboration process utilizing the proposed methodology to identify, evaluate, mitigate and monitor the micro risks uncertainty level which can impact any part of the internal process supply chain".

| Authors | SCRM Risk Types |
|---|---|
| [5] | Physical, financial, informational, relational and innovational risks |
| [6] | Disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity risks |
| [7] | External to the network: environmental risk.<br>External to the firm but internal to the supply chain network: demand & supply risks.<br>Internal to the firm: process & control risks. |
| [8] | Endogenous risks: market & technology turbulence.<br>Exogenous risks: discrete events (i.e. Terror attacks, worker strikes) & continuous risks (i.e. Inflation rate, consumer price index change). |
| [9] | Internal operational risks: demand, production & distribution, supply risks.<br>External operational risks: terror attacks, natural disasters, exchange rate fluctuations. |

Table 2. Definitions of supply chain risk types identified by selected-research.

**2.3 Supply Chain Risk Management Analysis**

Prior to the introduction of ISO 31000, significant amount of research and analyzed studies were published by synthesizing the data into diversified categories, i.e. environmental risk factors, industrial, organizational, specific problem, decision making, supply and demand management, product, information and project management. These are evidently few factors which have contributed to form a group of risk management processes and best practice models proposed by the Supply Chain Risk Leadership Council (SCRLC) i.e. Bow-Tie Risk Analysis Method and "Heat" Mapping. Most of its best practices and methodology frameworks closely relates to the ISO 31000 to ensure the standards are met and quality is enhanced.

*"Supply Chain Risk Leadership Council is an industry council comprised of world class supply chain firms working together to develop and share supply chain risk management standards and best practices. Its mission is to work together to create best-practices supply chain risk management standards, processes, capabilities and metrics to be adopted within the respective organizations. Leverage this best practices effort to proactively initiate consistency across industries and their related organizations / councils. Enable standardizations across industries where applicable and become "industry integrators" for the betterment of a more efficient and consistent risk management environment.."* – Source: SCRLC.

With regards to all these frameworks and best practice tools, many researchers have contributed to numerous amounts of findings and frameworks. It can be agreed that there are three gaps in SCRM

upon conducting open and close ended surveys; 1) definition gap (lack of understanding the SCRM definition), 2) process gap (poor or insufficient coverage for risk analysis) and 3) methodology gap (lack of applying empirical methods).

Ref. [10] proposed several elements to support this paper's conceptual framework which will close the process gap. Because this framework defines both external and internal risk management in the form of two categories – macro risks (catastrophic) and micro risks (operational). Macro risks refer to relatively external events that could cause a single point of failure (SPOF) which can create a serious negative impact to an organization. This includes any form of natural risks (earthquakes and weather related disasters) and man-made risks (political instability, war and terrorism). Micro risks on the other hand, refer to recurrence events originated from the internal operation process of an organization and/or relationship within its partners in the entire supply chain. Ref. [10] have generalized by defining macro risks carries a greater negative impact on an organization in relation to micro risks. They have also divided the micro risks into four subcategories; 1) demand risk, 2) manufacturing risk, 3) supply risk and 4) infrastructure risk. Ref. [10] developed a framework with a key focus point in manufacturing risk as the core element and integrated the other risks as peripheral elements. Because their research classified the framework by tying the manufacturing risk with supply and demand risk (sub-micro risks), as the authors defined micro risks are inclusive of its supply chain partners (upstream – suppliers; downstream – customers demand) and integrated a series of micro risks (information technology, transportation and financial system) as infrastructural risks as these three systems are critical drivers in the supply chain network. This framework fits well for the current trend in the supply chain as manufacturing organizations are prone to extreme risk factors throughout its internal and external process.

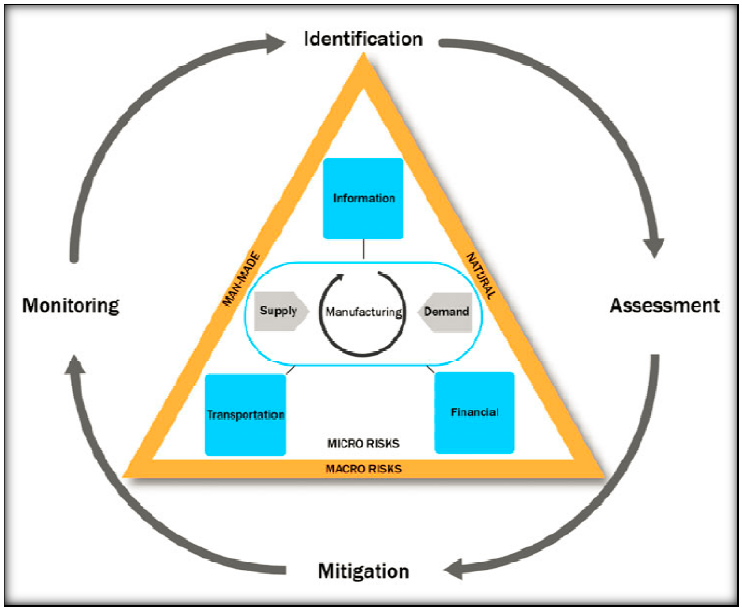



Figure 1. Conceptual framework of supply chain risks [10]

### 2.4 Conceptual Framework for Design Industry Process Gap SCRM

In application of the model, the design industry experiences a greater negative impact in its micro risks rather than the macro risks, a complete shift in risk factors [10]. This is purely because the design industry carries the front line process of any final product. Although the aforementioned four subcategories of micro risks are not entirely applicable in the design industry, supply and demand risk in the form of inter-department deliverable are the critical components with marketing, sales and quality department being the external components. This is the missing element in the typical best practice design industry's process flow as illustrated in Figure 2, without any risk management element. The macro risk can still exist in any form due to the industry globalization has the potential to encounter a disruption with similar impacts (natural risks and man-made risks) [10].

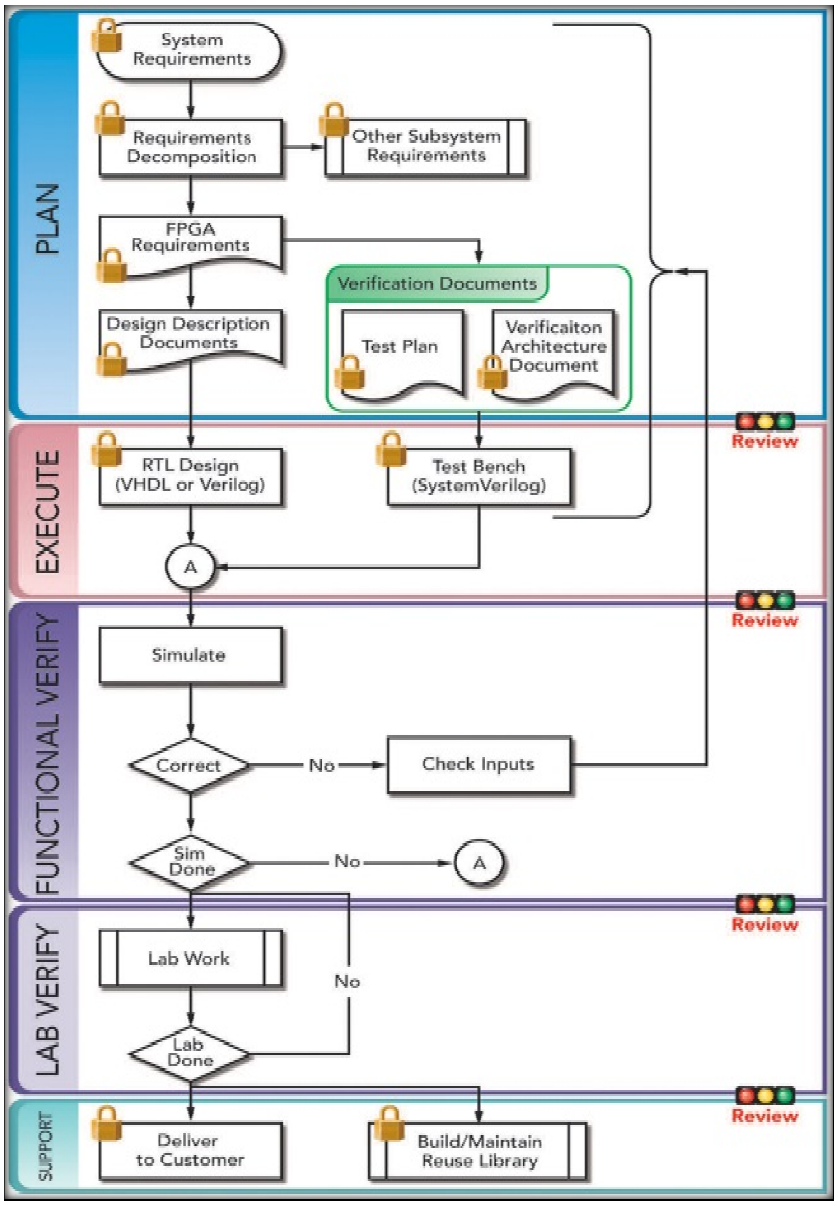



Figure 2. Typical Best Practice Electronic Design Process [11]

This paper offers a practice-based view of risk management within the inter-department and

internal process supply chain, a modified conceptual framework based on the above mentioned model [10]:

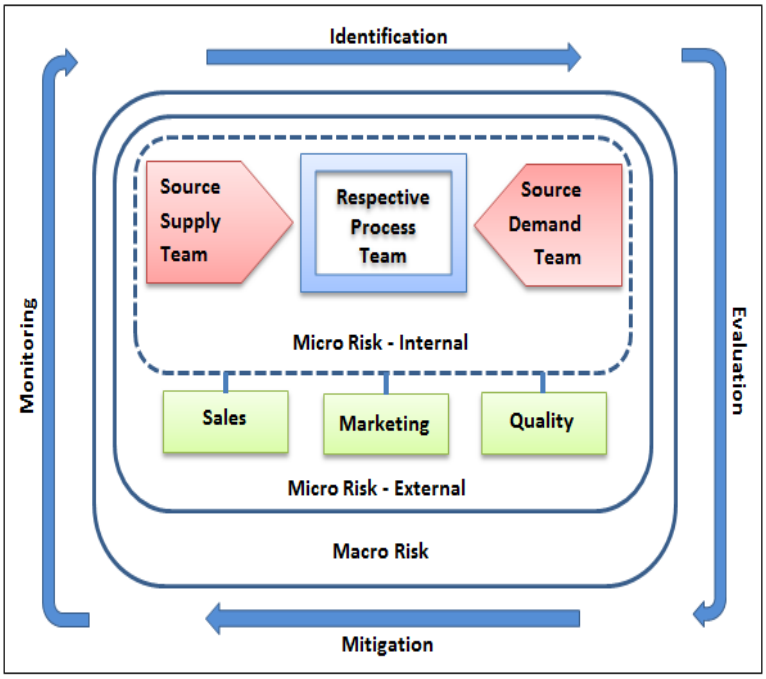
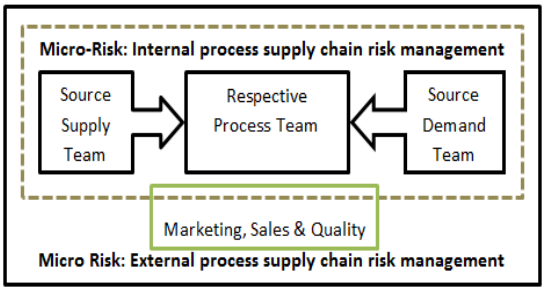



Figure 3. Proposed Risk Management conceptual framework for Electronic Design Industry.

**Model A – Micro Risk – Internal**


Internal process supply chain risk management should be applied throughout all steps of the design process.

**Model B – Micro Risk – External**




Internal and external process supply chain risk management should be applied throughout all steps of the process, focusing on a collaborated aspect to align with marketing, sales and quality department.

## 3. Applying the modified model in the design industry [10]

From a practitioner's point of view, the risk management framework ideally should be embedded into each internal process of the project design process – within inter-department and throughput the internal process chain. Purely due to the respective process team has a dependency on the receivables and deliverables from both ends of the process flow.

### 3.1 Elements

*3.1.1 Source Supply Team*

Every department in the design process flow will be accountable in being the source element during when the SCRM process initiates. The risk management formulation (identify, evaluate, mitigate and monitor) must be analyzed prior to deliverables by minimizing or eliminating any potential uncertainties.

Expected result with SCRM:

1) Potential threats are visible and calculated risks are available during deliverable.
2) Contingency plans are forecasted upfront from every angle of the process requirement. i.e. resources backup, tools readiness, alternate document reviewing process and priorities

3) External processes are triggered automatically for the respective process to spell out and react in parallel – if any impacts are potential glitch for the marketing, sales and quality.

*3.1.2 Source Demand Team*

Every inter-department and subsequent department throughout the design and release process will be the demand driver as it gets closer to the end customers requirement. There will be two sets of processes occurring in parallel:

i) Inter-department internal process

Inter-departments internal process comprises of relevant design requirements are captured and plugged in to series of documentation for every internal process to avoid any glitches during internal compilation. This is also to avoid any potential slip in project time management if the subsequent department captures the design gap and reverts back to the relevant process team.

ii) Previous and subsequent departments internal process

Throughout the design process at a given point of process flow, Source and Respective process team will be the receivable from its previous chain (Respective Process Team). In current practice, the demand source team from subsequent process is very biased and influenced by ad-hoc specifications/requirements. This type of spontaneous add-ons or change in any dependent parts of a product design is not visible to the source or respective process team during their process is being executed – such conditions are the common threat in process gaps.

Expected result with SCRM:

1) The continuous loop formulation for SCRM will create a gap in this situation as the uncertainty/risk identification nominator will be in the form of subsequent process and external department. But with the availability of the SCRM embedded in every internal and subsequent process flow, advantage would be on the visibility of any potential add-on requirements. Therefore, the identification, evaluation, justification and monitoring process will occur prior to handshake process from within inter-department and to subsequent process– Respective Process Team will be informed upfront as the situation has been mitigated earlier and conveyed either before or during process kick-off.
2) Potential impacts on any form minor and major impacts are triggered to the external department to pre-plan as counter action or workaround for any potential timeline or other form of receivables or deliverables dependency to their processes.

*3.1.3 Respective Process Team*

In every step of the design process flow, every inter-department and subsequent department will be representing this block. The primary goal for the SCRM to be implemented in this design industry is to create a value added function to ensure an efficient and effective operation process is in place and to create a competitive advantage in this industry as product launch as first mover opportunity is crucial.

Expected result with SCRM:

1) A win-win situation for every department and aligns to any design industries strategic fit within its inter-functional scope.
2) No requirements/necessary to re-strategize for any project crunch period. With SCRM in place, every department is aligned and fine-tuned upfront to withstand and accept any calculated risk factors.
3) Automatically drives towards the organizations vision and mission – if applicable.
4) Deliverables are consolidated with high quality assurance with no or minimum process risk gaps.
5) A full prove formulation of SCRM has the potential to even re-structure the design process flow with a leaner flow by eliminating any process which has its potential process gaps closed with no risk factors due to receivables and deliverables are constantly monitored with SCRM formula – long term process as data analysis is crucial for such conditions.

**3.2 Model A and Model B: Integrated Supply Chain Risk Management (ISCRM)**

Based on the arguments earlier, this paper is proposing companies in design industry to have an integrated internal and external supply chain risk management process flow plugged in to every stage of the design process flow.

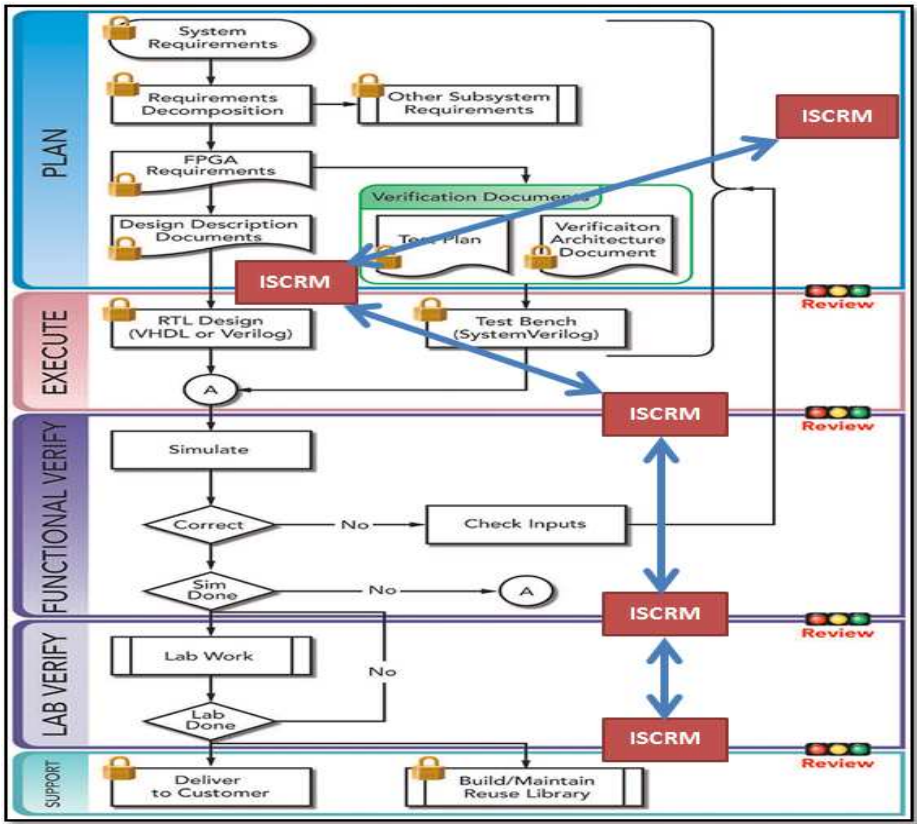



Figure 4. Enhanced Best Practice Electronic Design Process with ISCRM.

*Note: Current loopback processes have the potential to be made leaner by reducing the subsequent process gaps uncertainty, i.e. the loopback process from Functional Verification department to Design Planning and Execution Department can be eliminated with full prove ISCRM and sustain/contain the purpose of this loopback within Design Planning and Execution Department.*

## 4. Discussion

### 4.1 Risk Uncertainty Challenged with Process Gap Closure

Even though a standard operating procedure (SOP) spells out the ideal operating conditions for electronics design industry, the supply chain regardless of being internal, sub-external or external is experiencing some form of turbulence, for instance employee turnover, increasing number of competitors, government/political instability leading to many unknown factors to arise (taxation and new law) and market demand trends spontaneously.

With these factors pose uncertainty risks which are not visible and forecasting it becomes merely impossible. These are the types of risks in which

firms in the design industries are struggling to minimize. Larger firms might have the capacity to outrun the risk uncertainty factors as they have more financial resources buffering the risks. New and trending firms, however have to struggle to overcome such conditions. In extreme cases, these uncertainties have caused several breakdowns in operations and eventually lead to major shutdowns or being acquired by other competitors. For example, recently in Malaysia; Atmel is now acquired by Microchip, Avago is now Broadcom, Fairchild in Penang, is no more operational, OSRAM and Phillips had to re-strategize business plan frequently.

As much as the big threats are being induced from the outside world, an organization, especially the firms in the electronic design industry have the capacity to forecast certain elements of the threats before it causes a major meltdown in its operation. The major root causes are the failure to identify and close the process gaps before a major disruption in its supply chain occurs (internal, sub-external and external).

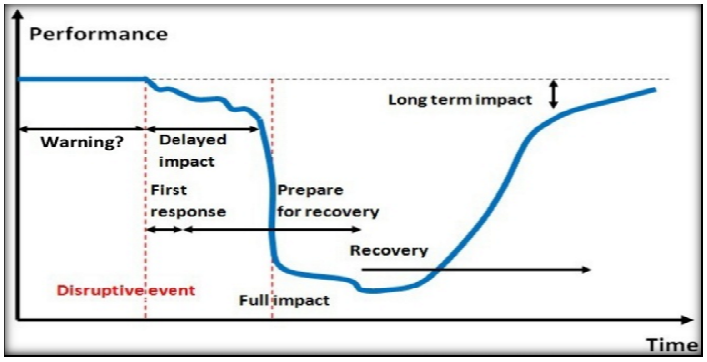



Figure 5. Supply Chain Disruption and Ramp up Time [12]

### 4.2 Practice-based view to counter Process Gap

This paper addresses the process gap in design industry by introducing a conceptual framework on a practice-oriented view based on the model [10]. Based on the first author's experience in risk management in terms of avoiding risk during design release stage, which comes into effect at project release timeline tends to promote more process gaps. Therefore, introducing a supply chain risk management (SCRM) as a process which embeds into the entire design process will ensure any design project is completed within a given time frame (with lean management system incorporated by default) which creates a higher value chain in terms of launching the product to the market with no or minimum risk uncertainty delays caused by internal process gaps.

### 4.3 Potential Application of the Framework

Referring to the standard practice of an electronic design industry (Figure 2), any organization which applies similar practice in its design process can consider applying this Integrated Supply Chain Risk Management (ISCRM) conceptual framework to overcome the process gaps. The formulated strategy for risk management is a continuous process whereby a respective project team can consolidate the data with inputs from source, respective and demand team by an integration of inputs/outputs with the external departments – marketing, sales and quality (receivables and deliverables are visible).

## 5. Conclusion

Internal process risk management in the electronic design industry is one of the most critical areas a business entity should focus on. This paper presents the importance of micro-managing the controllable internal risk processes at every stage as to sustain the entire supply chain performance and profitability. As the operational saying "Do it Right the First Time", is what every company is striving for but without a proper Supply Chain Risk Management practice in place, it could lead to extreme failure. The proposed conceptual framework serves as a practical guide for industry practitioners on addressing the internal process risk and ensuring business continuity.

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