Supply Chain Coordination in New Product Development

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Supply Chain Coordination in NPD

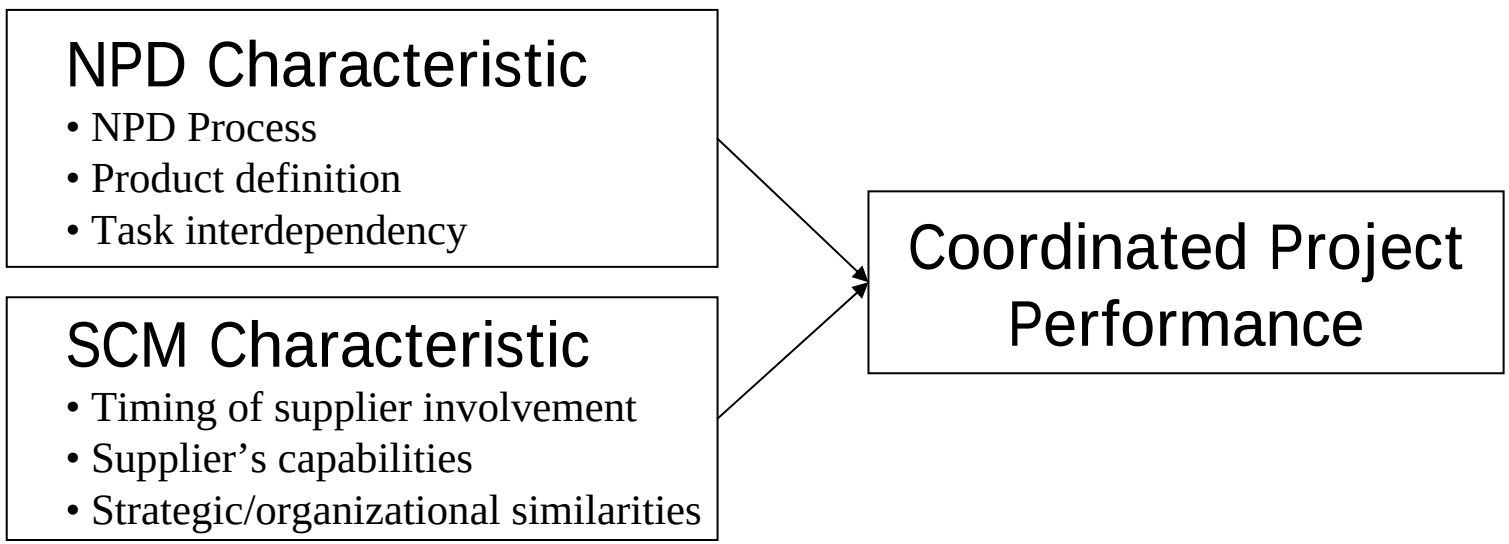
- Supplier Involvement in New Product Development
  - Early supplier involvement is generally defined as a form of vertical cooperation in which manufacturers involve suppliers at an early stage in the product development and/ or innovation process (Bidault et al., 1998).
  - Involving suppliers in NPD is one way of gaining strategic flexibility through reduced cost, reduced concept-to-customer development time, improved quality, and access to innovative technologies that can help firms gain capture market share (Handfield et al., 1999).

Research Motivation

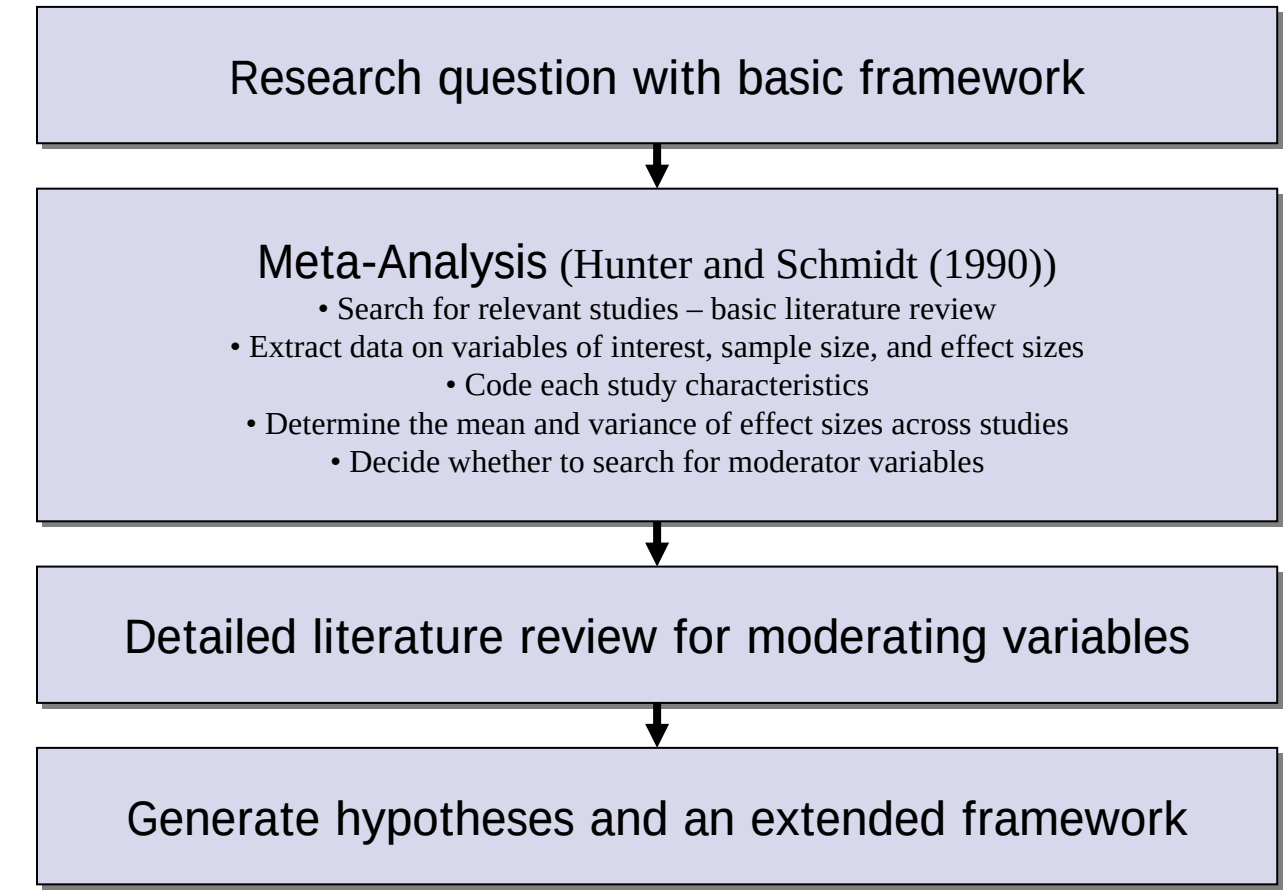
- "Conflicting" Effects of Supplier Involvement
  - Companies have involved suppliers in their NPD processes, achieving *fast project times* (Clark, 1989; Clark and Fujimoto, 1991), *better product quality* and *lower project costs* (McGinnis and Vallopra, 1998;Ragatz et al., 1997).
  - However, other researchers have found that suppliers have *little practical influence* on the overall project technical success (Hartley et al.,1997), and *even a negative impact* on project development time if they delay their activities (King and Penleskey, 1992). Also, in a literature review of product development, Brown and Eisenhardt (1995) show that it is *not clear* exactly how or when it is appropriate to involve suppliers in the development process.

Research Objective & Question

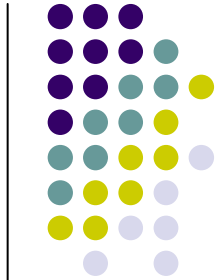
- Investigate whether the supply chain coordination efforts improves the performance of new product development and, if so, whether there exists any moderators
- Generate hypotheses that make it clearer the relationship between supply chain coordination and the performance of new product development project



Research Procedures



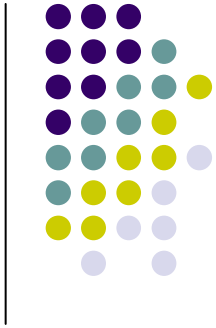
Meta-Analysis:
(1) Data Collection



- Electronic database
  - Computer search of the *National Digital Science Library (NDSL)** using the following Boolean expression based on a review of the abstracts
  - AB= supplier [AND] (involvement [OR] integration) [AND] product
  - Year: 1995 or later
  - Journals from the management, management science, marketing, operations management, service management, and technology management literature
- Reference sections of articles
  - Google scholar
- Published articles only in English

* NDSL is a Korean archive portal which collects famous electronic databases including EBSCO host, ScienceDirect, and ProQuest

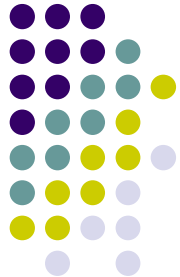
Meta-Analysis:
(2) Characteristics of Research Samples



Sample size

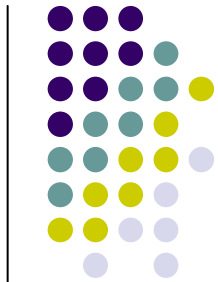
No.	Study	Methods	Country	Industry	Firm Size	Years	N
1	Ledwith and Coughlan (2005)	Correlation	Ireland,UK	Electronics	Mixed	N/A	60
2	Eisenhardt and Tabrizi (1995)	Regression	Mixed	Computer	N/A	N/A	72
3	Hartley et al. (1997a)	ANCOVA, Regression	US	Mixed	Small/Mec	N/A	79
4	Saxton (1997)	Correlation, Regression	Mixed	Chemical	N/A	1994-1995	98
5	Tan and Tracey (2007)	Path Analysis	US	Manufacturing	Mixed	N/A	175
6	Sobrero and Roberts (2001)	Regression	Europe	Home appliances	N/A	N/A	50
7	Primo and Amundson (2002)	Regression	N/A	Electronics	N/A	N/A	38
8	Zirger and Hartley (1996)	Regression	US	Electronics	N/A	N/A	44

Meta-Analysis:
(3) Corrections for Artifactual Attenuation of Study Correlations



- Correction for sampling error
  - Corrected estimate of mean correlation: $\bar{r} = \frac{\sum_i N_i r_i}{\sum_i N_i}$
  - Corrected estimate of study correlation variability: $S_r^2 = \frac{\sum_i \left[N_i (r_i - \bar{r})^2 \right]}{\sum_i N_i}$
  - Corrected estimate of sampling error variability: $S_e^2 = \frac{K(1-\bar{r}^2)^2}{\sum_i N_i}$
    (K=number of studies)
  - Corrected estimate of variability of the population correlation:
    $S_\rho^2 = S_r^2 - S_e^2$

Meta-Analysis:
(4) Hunter and Schmidt's Heuristics



- RATIO1
  - RATIO1$(=\frac{\bar{r}}{S_\rho}) \geq 2 \Rightarrow$ reasonably safe to say " Corr_pop > 0 "

    ⇨ The factor affects the performance positively
- RATIO2
  - RATIO2$(=\frac{S_e^2}{S_r^2}) \geq 0.75 \Rightarrow$ reasonably safe to say " there is one Corr_pop "

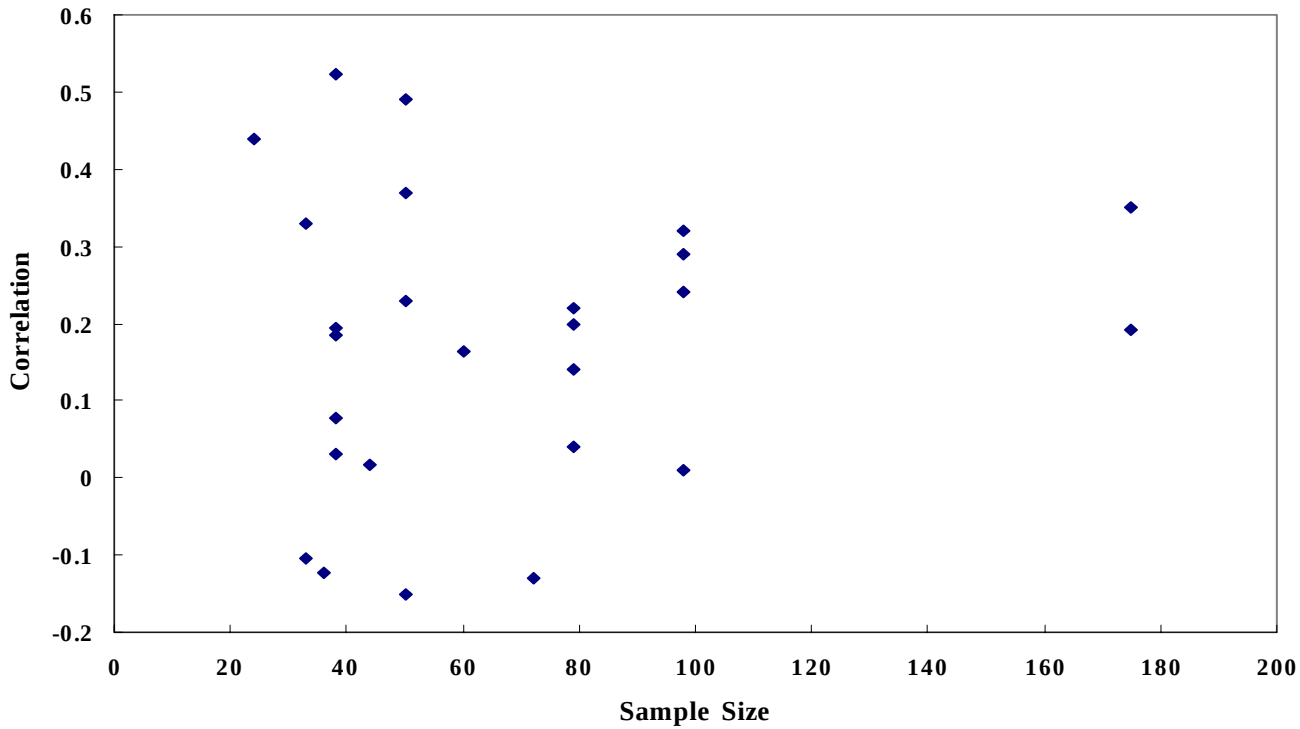
    ⇨ Other variables are not likely to act as moderators

Meta-Analysis:
(5) Performance Measure and Supplier Involvement Characteristics

No.	Study	Methods	Performance Measure	SCC Characteristic	N	Corr.	Signif?	Country	Industry
1	Ledwith and Coughlan (2005)	Correlation	Project Success	Level of Cooperation	36	-0.122	No	Ireland	Electronics
1	Ledwith and Coughlan (2005)	Correlation	Project Success	Level of Cooperation	24	0.44	p≤0.05	UK	Electronics
1	Ledwith and Coughlan (2005)	Correlation	Project Success	Level of Cooperation	33	-0.105	No	Ireland,UK	Electronics
1	Ledwith and Coughlan (2005)	Correlation	Project Success	Level of Cooperation	33	0.329	No	Ireland,UK	Electronics
1	Ledwith and Coughlan (2005)	Correlation	Project Success	Level of Cooperation	60	0.163	No	Ireland,UK	Electronics
2	Eisenhardt and Tabrizi (1995)	Regression	Development Time	Stage number of supplier involv	72	-0.13	No	Mixed	Computer
3	Hartley et al. (1997a)	ANCOVA, Reg	Project's overall delay	Supplier's technical capabilities	79	**0.22**	No	US	Mixed
3	Hartley et al. (1997a)	ANCOVA, Reg	Project's overall delay	Length of the supply relationshi	79	**0.04**	No	US	Mixed
3	Hartley et al. (1997a)	ANCOVA, Reg	End product quality	Supplier's technical capabilities	79	0.2	No	US	Mixed
3	Hartley et al. (1997a)	ANCOVA, Reg	End product quality	Length of the supply relationshi	79	0.14	No	US	Mixed
4	Saxton (1997)	Correlation, Re	Alliance outcome	Prior relationship	98	0.24	No	Mixed	Chemical
4	Saxton (1997)	Correlation, Re	Alliance outcome	Strategic similarities	98	0.32	p≤0.05	Mixed	Chemical
4	Saxton (1997)	Correlation, Re	Alliance outcome	Organizational process similariti	98	0.01	No	Mixed	Chemical
4	Saxton (1997)	Correlation, Re	Alliance outcome	Degree of shared decision makin	98	0.29	p≤0.01	Mixed	Chemical
5	Tan and Tracey (2007)	Path Analysis	Customer satisfaction	Collaborative NPD environment	175	0.35	p≤0.01	US	Manufactu
5	Tan and Tracey (2007)	Path Analysis	Customer satisfaction	Degree of supplier involvement	175	0.192	p≤0.05	US	Manufactu
6	Sobrero and Roberts (2001)	Regression	Efficiency of relationship	Design scope of relationship	50	0.23	No	Europe	Home appli
6	Sobrero and Roberts (2001)	Regression	Efficiency of relationship	Level-of-task interdependency	50	-0.15	No	Europe	Home appli
6	Sobrero and Roberts (2001)	Regression	Learning of relationship	Design scope of relationship	50	0.49	p≤0.01	Europe	Home appli
6	Sobrero and Roberts (2001)	Regression	Learning of relationship	Level-of-task interdependency	50	0.37	p≤0.01	Europe	Home appli
7	Primo and Amundson (2002)	Regression	Quality index	Supplier involvement	38	0.522	p≤0.05	N/A	Electronics
7	Primo and Amundson (2002)	Regression	Project speed	Supplier involvement	38	0.185	No	N/A	Electronics
7	Primo and Amundson (2002)	Regression	Projected R&D budget	Supplier involvement	38	0.195	No	N/A	Electronics
7	Primo and Amundson (2002)	Regression	Time-to-market objective	Supplier involvement	38	0.031	No	N/A	Electronics
7	Primo and Amundson (2002)	Regression	Product cost objective	Supplier involvement	38	0.077	No	N/A	Electronics
8	Zirger and Hartley (1996)	Regression	Development Time	Supplier involvement	44	**0.017**	No	US	Electronics

Meta-Analysis:
(6) Funnel Plot

- Funnel shaped ⇨ sampling error decreases as sample size increases ⇨ satisfying the assumption that there is one underlying effect size



Meta-Analysis:
(7) Results of the Meta-Analyses

- Corrected Estimates

$$\bar{r} = 0.198,\ S_r^2 = 0.021,\ S_e^2 = 0.013,\ S_\rho^2 = 0.007$$

- Does supplier involvement improve the project's outcome?

$$\text{RATIO1}\left(=\frac{\bar{r}}{S_\rho}\right) = 2.319 \geq 2 \Rightarrow \text{ reasonably safe to say " Corr\_pop > 0 "}$$

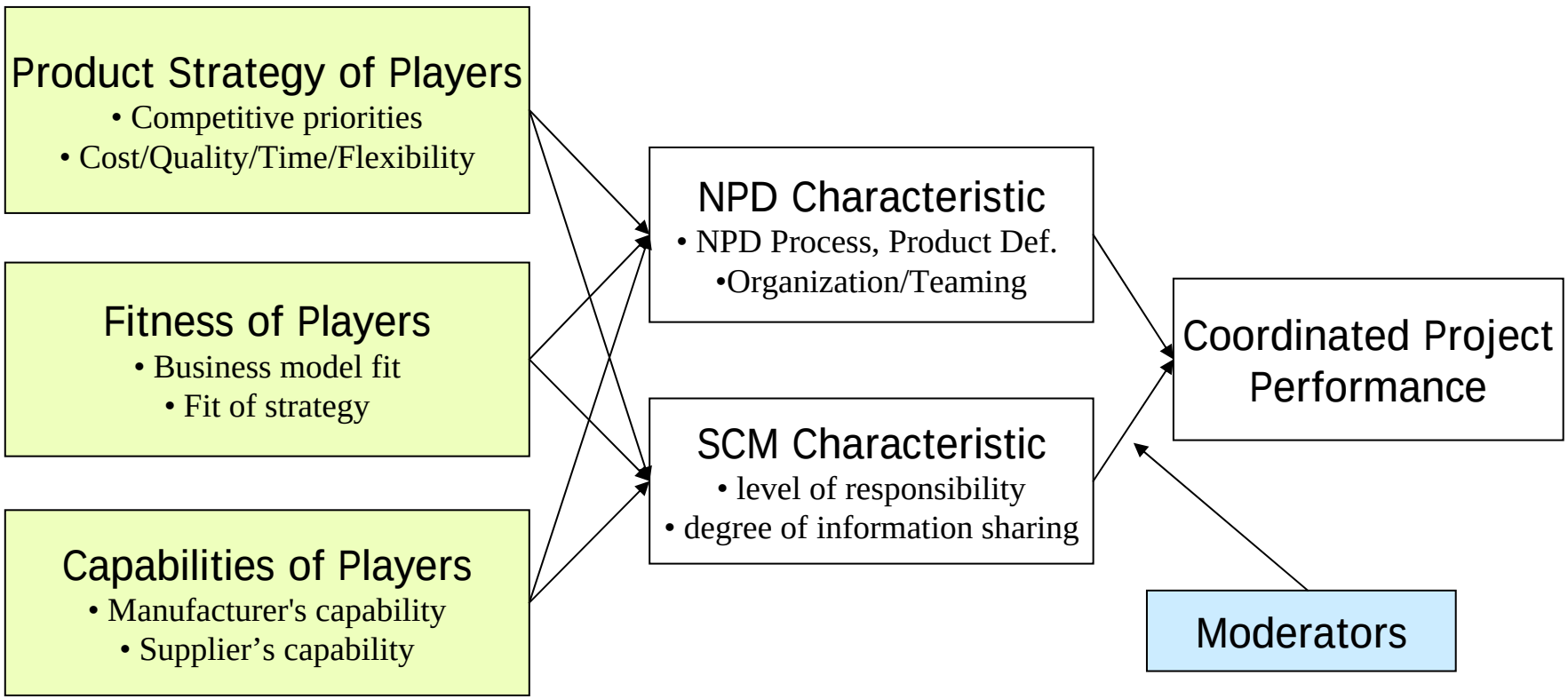
⇒ Supplier involvement improves the project's outcome

- Is there any moderator to affect the improvement?

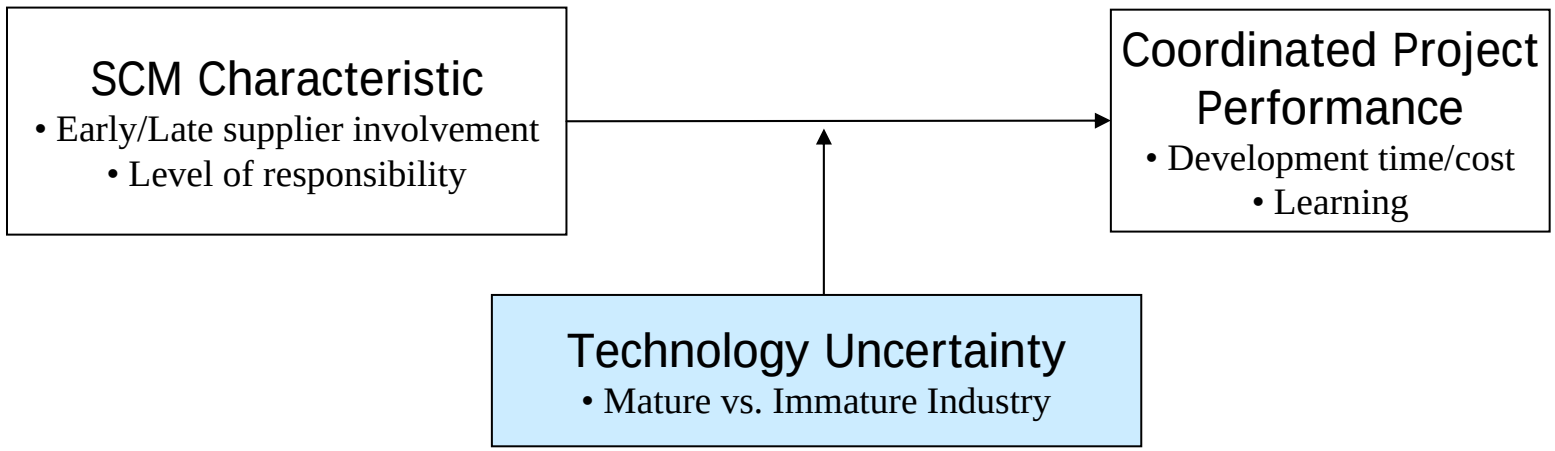
$$\text{RATIO2}\left(=\frac{S_e^2}{S_r^2}\right) = 0.646 < 0.75 \Rightarrow \text{ Not safe to say " there is one Corr\_pop "}$$

⇒ Other variables are likely to act as moderators

Extended Framework



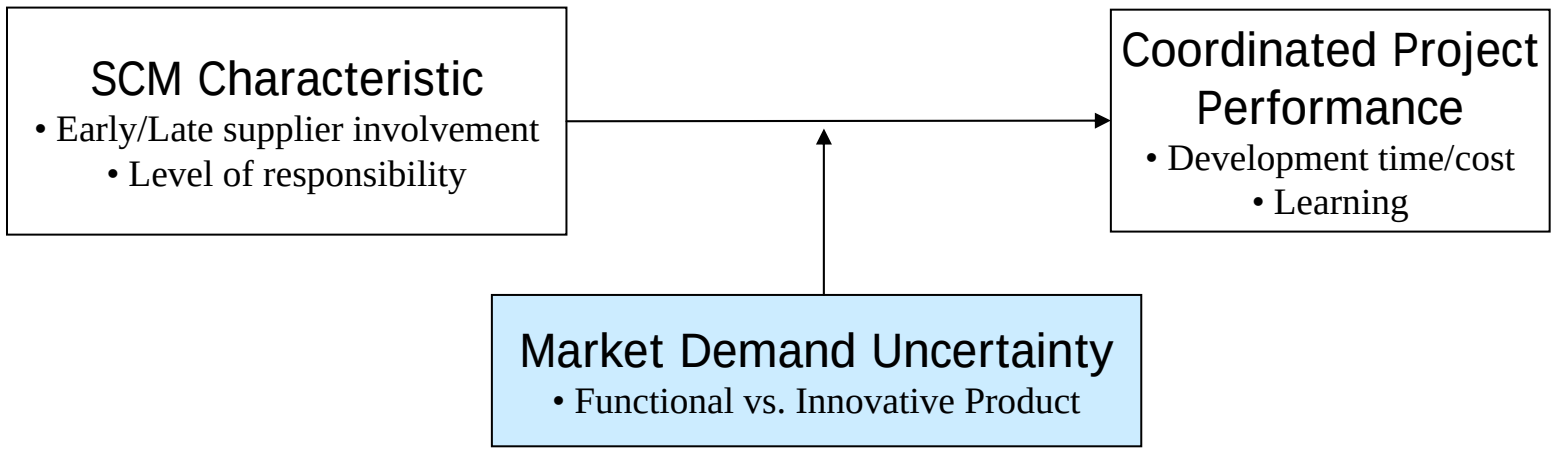
Hypothesis 1



H1a: In the ***mature*** industry, ***early*** supply involvement improves the coordinated project performance.

H1b: In the ***mature*** industry, supplier having ***more responsibility*** improves the coordinated project performance.

Hypothesis 2



H2a: In developing the ***innovative*** product, ***early*** supply involvement improves the coordinated project performance.

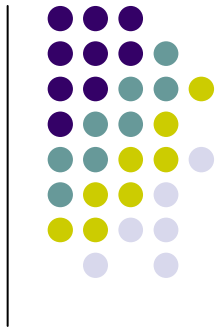
H2b: In developing the ***innovative*** product, supplier having ***more responsibility*** improves the coordinated project performance.

Contribution

- Through the meta-analysis of relevant literatures, this research shows that it is reasonably safe to say “the supplier involvement improves the performance of new product development project”
- Based on the detailed literature review, we find the highly possible moderators that change the effect size of supplier involvement.
- Generate the hypotheses that can identify the relationship between the supplier involvement and new product development.

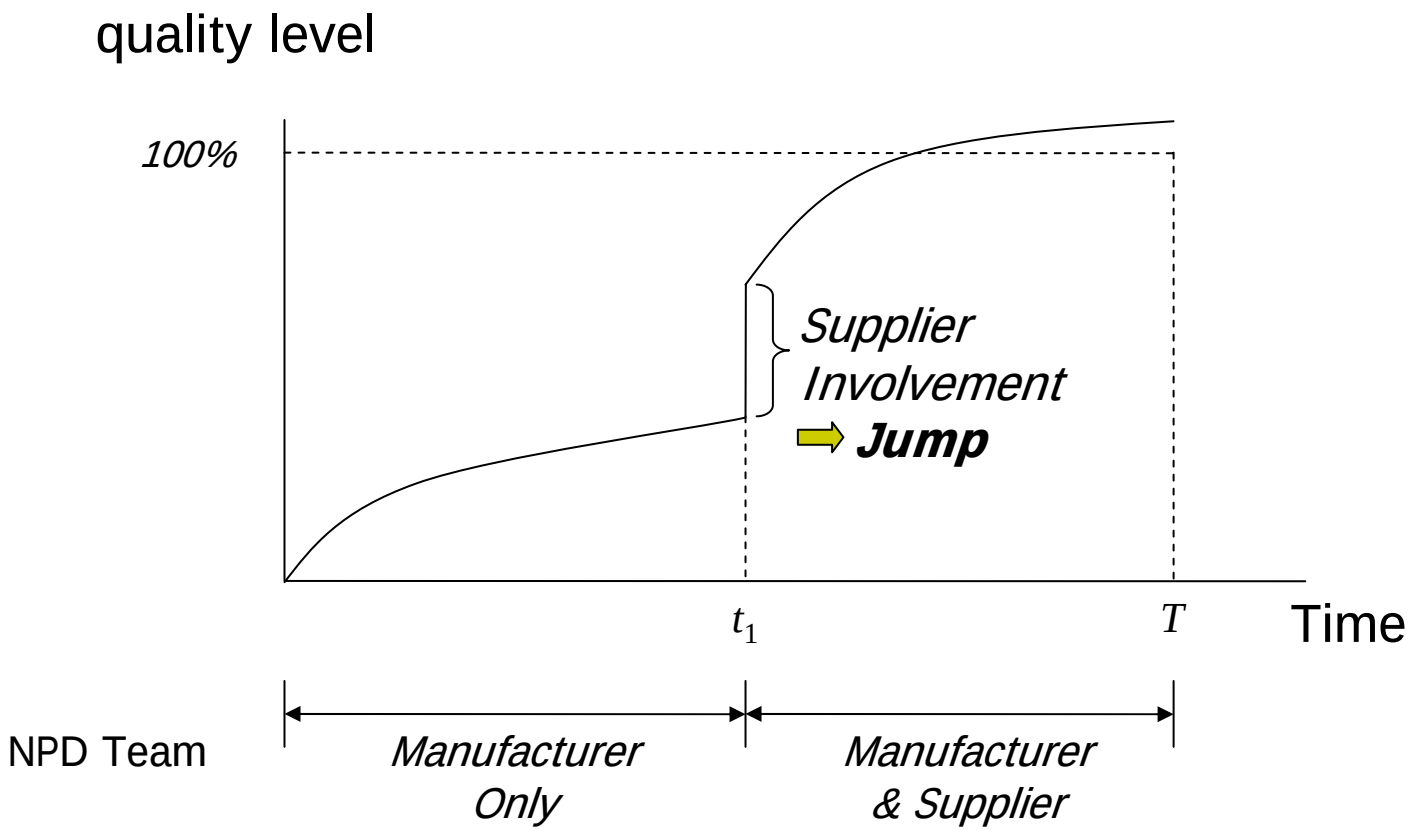
Limitation and Future Research

- For meta-analysis
  - Small numbers of studies that provide the correlation information between relevant variables.
  - Performance are not measured with same dimension.
  - Little literature have studied the performance of coordinated product development project with the perspective not only of supply chain but also of new product innovation.
- Empirical studies are needed to test the hypotheses we proposed.



Thank You For Listening
Questions or Comments?

Supplier Involvement Model



Variables

- **Control Variables**

  t_1 = timing of supplier involvement,

  $u(t)$ = investment efforts of manufacturer at time t.

- **State Variable**

  $x(t)$ = product quality level (or technology achievement level) at time t.

  $x^+(t_1)$ = product quality level after the supplier involvement

  $x^-(t_1)$ = product quality level before the supplier involvement

- **Notations**

  T = duration of NPD project

  b = decay rate of technology achievement

  $P(T,x(T))$ = lump sum profit at time t

  $f\,(t,x,u)$ = cost function of product development during project period

Optimal Control Model

$$\max_{\substack{u\ge 0\\ 0\le t_1\le T}} \int_0^T f(t,x,u)\,dt - c(t_1)(x^+(t_1)-x^-(t_1)) + P(T,x(T))$$

subject to

$$\dot{x} = u - bx,$$

$$x(0) = x_0 > 0, \quad x(T) \textit{ free},$$

$$u \ge 0,$$

$$x(t) = \begin{cases} x(0) + \int_0^t (u(s) - bx(s))ds, & 0 \le t \le t_1 \\ x(0) + \int_0^t (u(s) - bx(s))ds + (x^+(t_1) - x^-(t_1)), & t_1 < t \le T \end{cases}$$

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