34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

The System Dynamics Approach

A Model for Trust and Distrust

Paper#376

What is trust?

- Do you trust your family?
- Do you trust everyone in this room right now?
- Did you trust your flight to come to Dublin?
- How about automatic-driving or generative AI?
- Do you trust me?

Trust is difficult to grasp and develop?

- Trust remains an elusive phenomenon, in part because of the chameleon-like nature of trust, which can be leveraged in various ways.

(Marsh & Dibben, 2003)

- The lack of a measurable sense and theory of trust makes the modeling and evaluation of trust in AI almost impossible.

(Afroogh, 2023)

What are the Trust's recent topics?

- Trust among individuals, automation, and artificial intelligence.

- In 2019, the European Commission’s high-level expert group on AI issued the Ethics Guidelines for Trustworthy AI. (HLEG, 2019)

Trust needs a trustor and a trustee?

- Trusting is a communication from the side of the trustor as well as the trustee.
- The trustee's side expression: the trustee's competence and goodwill and their commitment to do what is expected.
- The trustor's side desire: the trustee will prove to be trustworthy, a positive feeling toward the trustee.

(Sutrop, 2019)

The objective of this study

- To view trust as a system, and to show who is a Trustee and who is a Trustee in the dynamic trust relationships from person to person, from person to automation and from person to AI.
- We present a larger perspective of trust and distrust that exist in social systems using systems thinking.

Framework of the Proposed Trust Model and Challenges

How to dynamically show Trust and Distrust

- We utilized the causal loop, as a modeling tool for systems thinking Sterman (2000)
- Mayer, Davis, and Schoorman's model of trust (MMT) (1995) is widely referenced
  - People and people: McKnight (1996)
  - People and Automation: Hoff and Bashir (2015), Lee and See (2004), and Malle and Ullman (2021)
  - People and AI: Lewis and Marsh (2022)
- Kohn et al. (2021) found that many trust measures align with elements of MMT Kohn, de Visser, Wiese, Lee, and Shaw (2021)

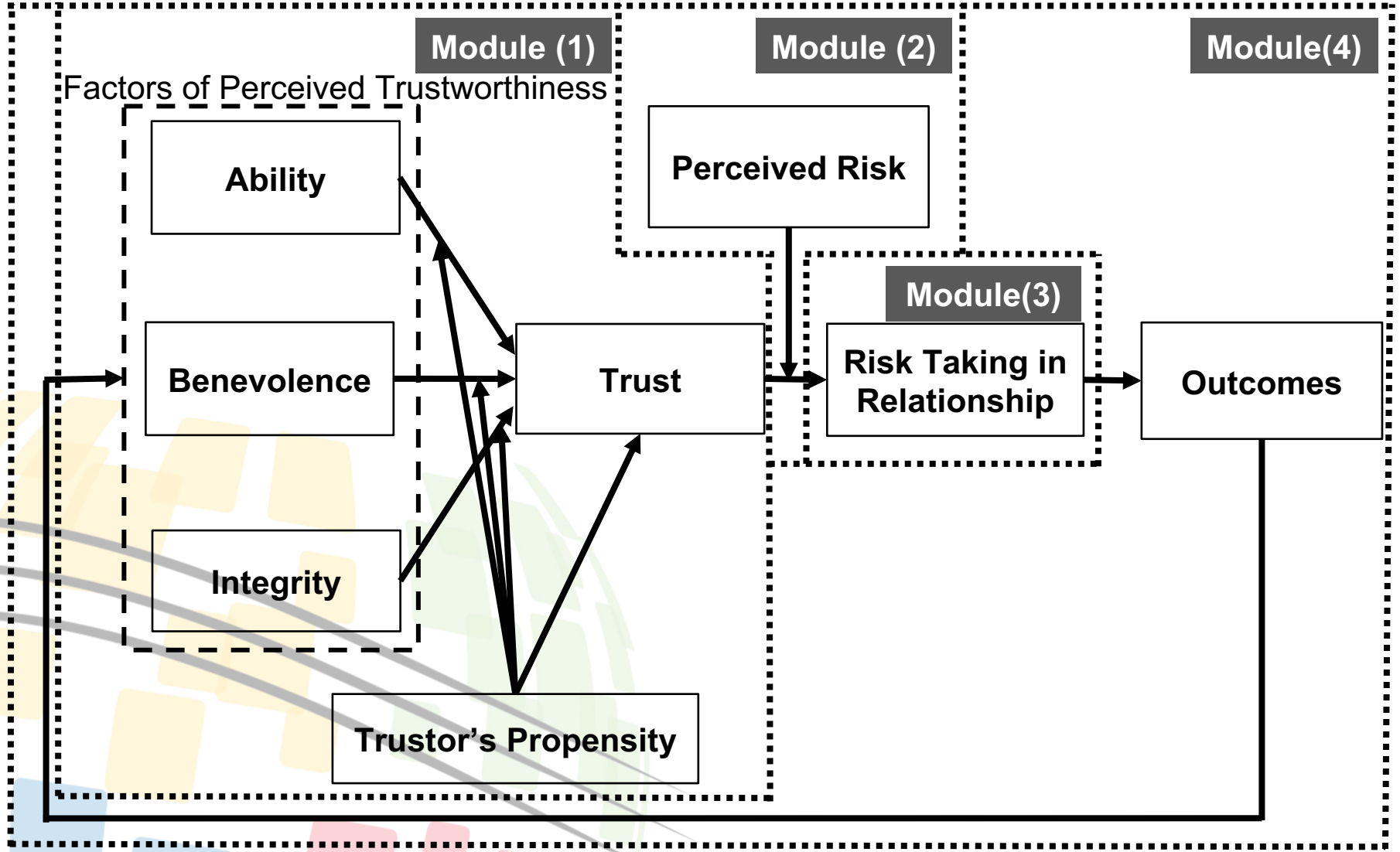
Trust and Distrust

(Kurstedt & Tech, 2003 p257)

- Kurstedt and Tech's model of trust (KMT) (2003) and its challenges is provided, and a system dynamics tool-based model of trust and distrust using the causal loop of systems thinking is presented.

Mayer, Davis, & Schoorman's Model of Trust (MMT)

Mayer, Davis & Schoorman's Model of Trust (MMT)



(Modules (1)-(4) were added by the author to Mayer, Davis & Schoorman, 1995, p. 715)

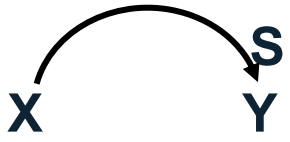
The MMT faces the following challenges

1. The relationship between elements and that between trustor and trustee is not shown
2. The four elements that affect “Perceived Risk” and the two elements that affect the Risk Taking in Relationship, which are presented in the main text of this study, are not shown in the figure
3. The elements related to trust formation and a block diagram are shown, but those related to distrust are not

Kurstedt & Tech's Model of Trust (KMT)

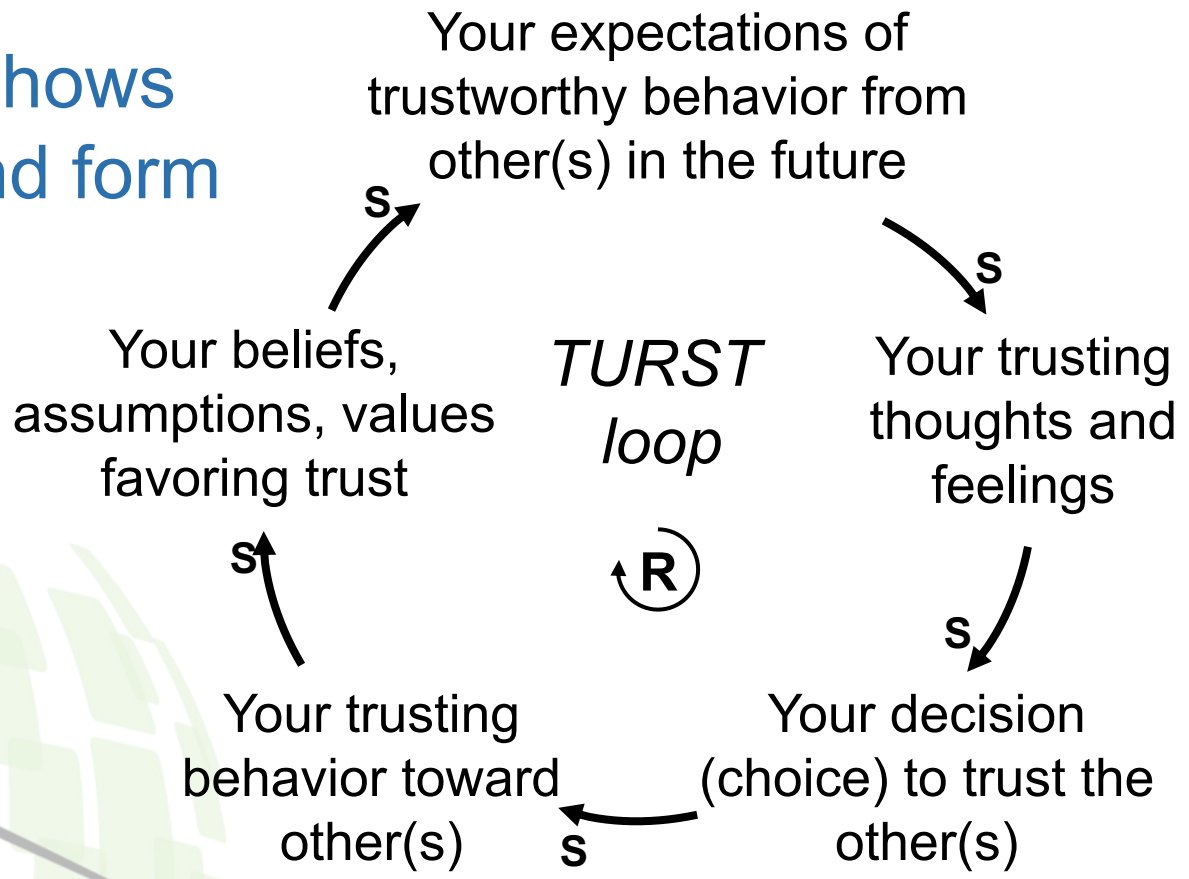
Causal Loop Definitions and Examples

(Sterman, 2000)

Symbol	Interpretation
	**Positive Link** If X increases (decreases), then Y increases (decreases). "S" indicates variation in the same polarity between the independent and dependent variables.
	**Negative Link** If X increases (decreases), then Y decreases (increases). "O" indicates variation in the opposite polarity between the independent and dependent variables.
	**Positive (Reinforcing) feedback loop.**
	**Negative (Balancing) feedback loop.**
My trust in you loop	Provide a name to each important feedback.

Kurstedt & Tech's Model of Trust (KMT) -1

This causal loop diagram shows that all links are positive and form a reinforcing loop.



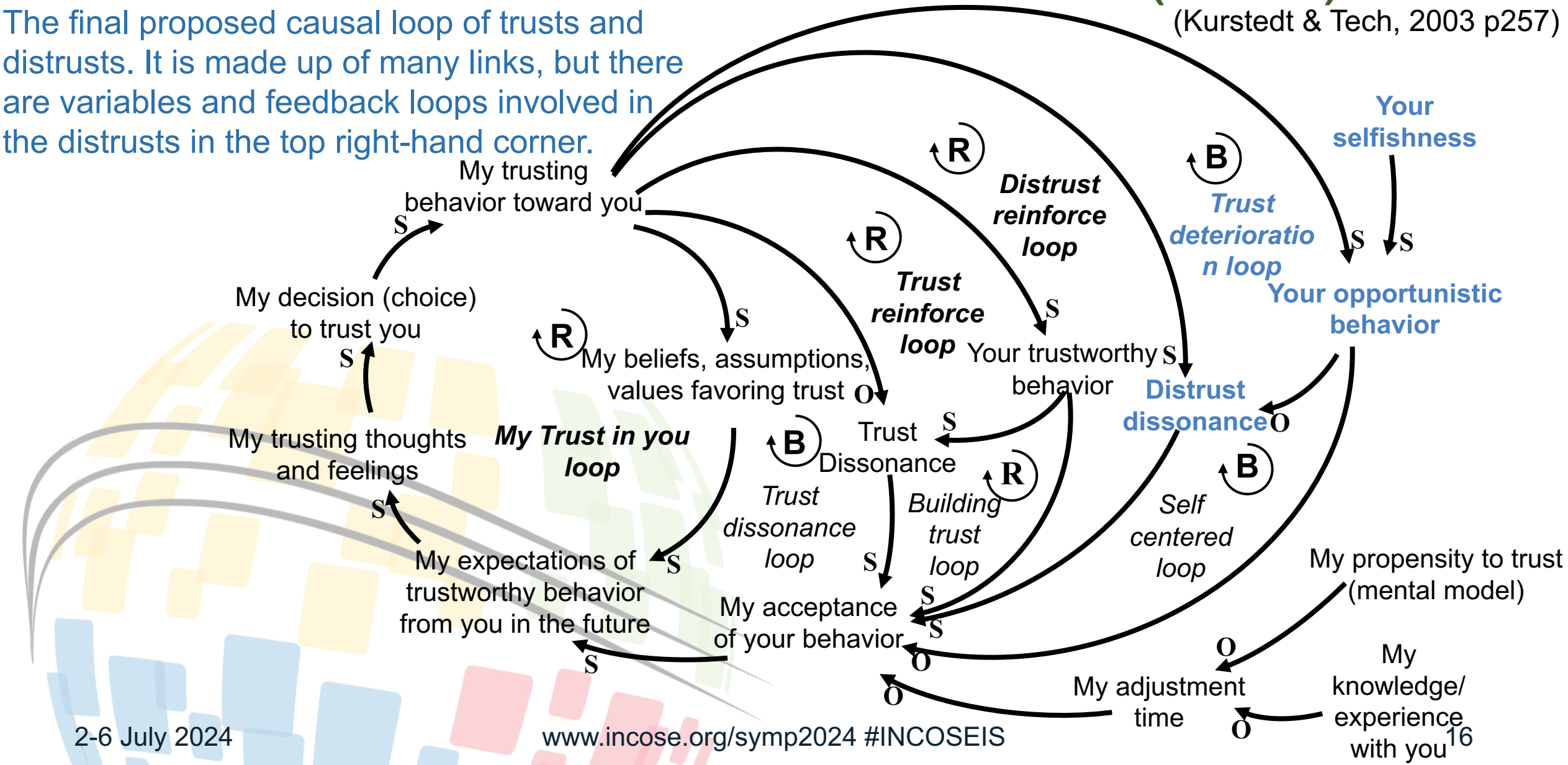
(Kurstedt & Tech, 2003 p251)

Mapping the Definition of Trust

Kurstedt & Tech's Model of Trust (KMT) -2

The final proposed causal loop of trusts and distrusts. It is made up of many links, but there are variables and feedback loops involved in the distrusts in the top right-hand corner.

(Kurstedt & Tech, 2003 p257)



Two major points are involved in resolving the issues between MMT and KMT

1. MMT comprised the components of trust, but the relationships among the components were not dynamically represented, which was shown as the dynamic model for trust
2. KMT constituted a dynamic model for both trust and distrust but was missing the trust component; therefore, the distrust part was decided to be utilized.

Elements and Variables

Dynamic Model for Trust

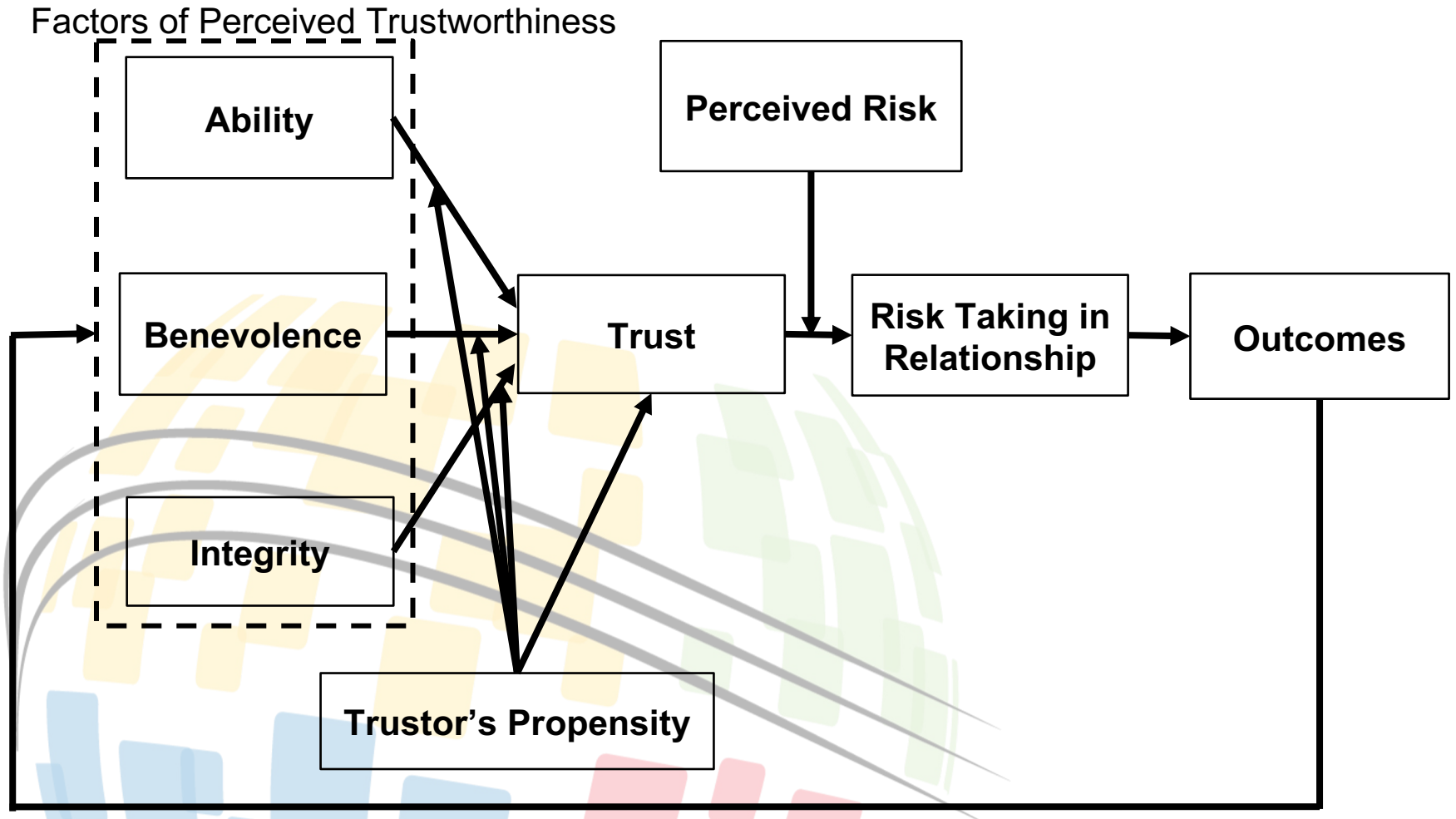
Causal Loop Diagram Drawing Procedures

(Sterman, 2000)

- Replace Elements with variables
- Connect variables with links
- Indicate "S" if the link is a positive link, "O" if it is a negative link
- Connect links via common variables to form a feedback loop
- Indicate "R" for a self-reinforcing feedback loop and "B" for a balanced feedback loop
- Name the important loops

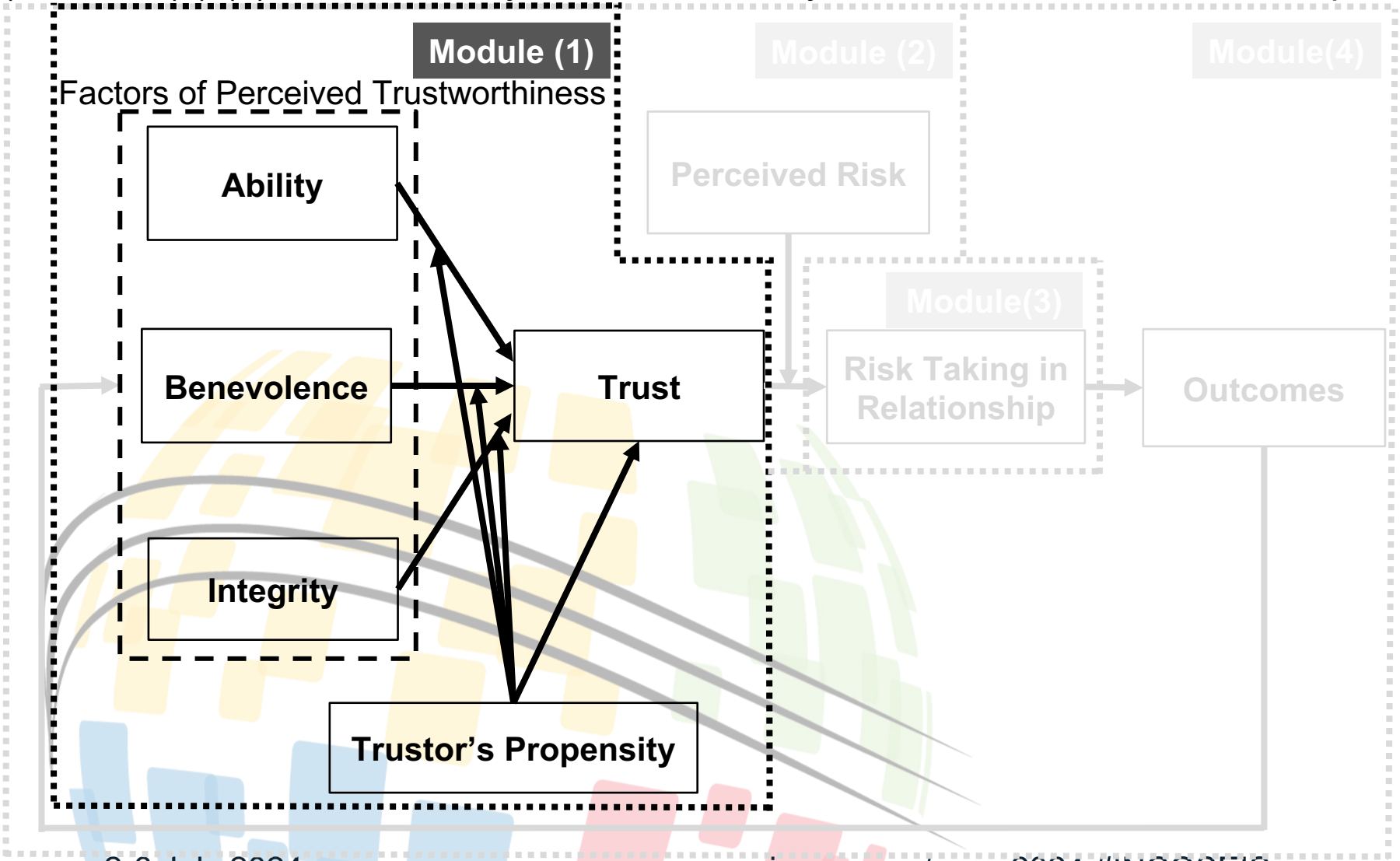
Mayer, Davis & Schoorman's Model of Trust (MMT)

(Mayer, Davis & Schoorman, 1995, p. 715)

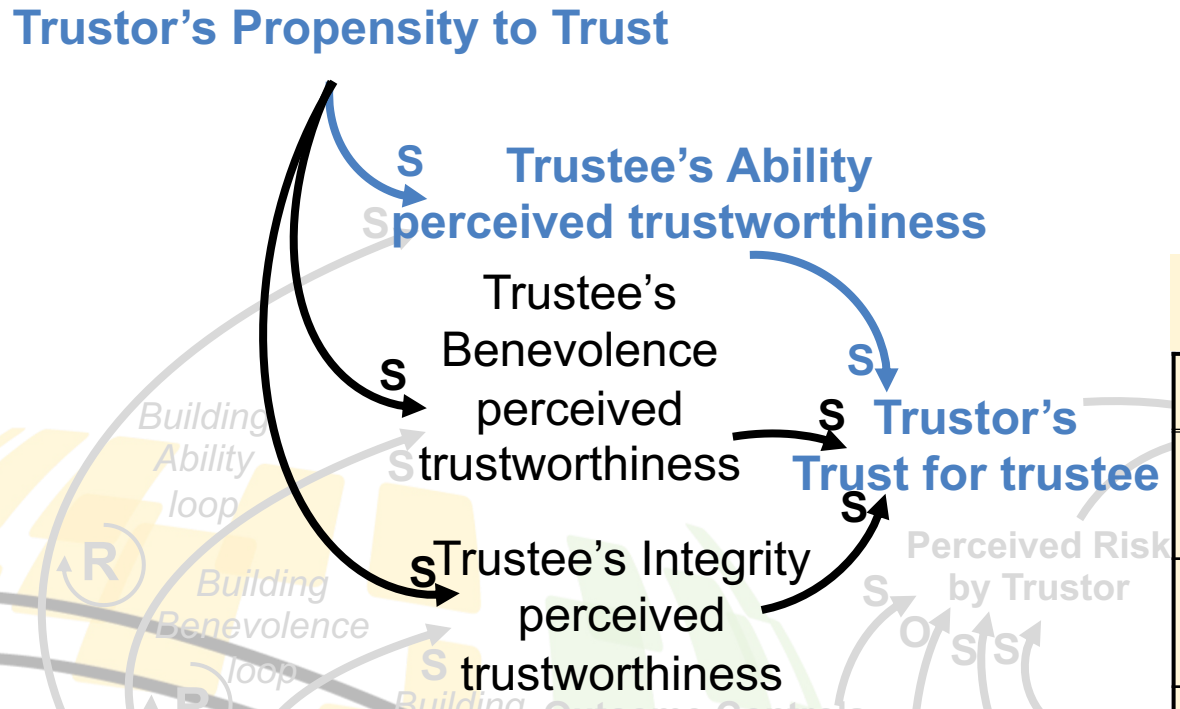


Module(1): Three Characteristics of a Trustee, Trustor's Propensity, and Trustor's Trust for Trustee

(Modules (1)-(4) were added by the author to Mayer, Davis & Schoorman, 1995, p. 715.)



Module(1): Example for making some links

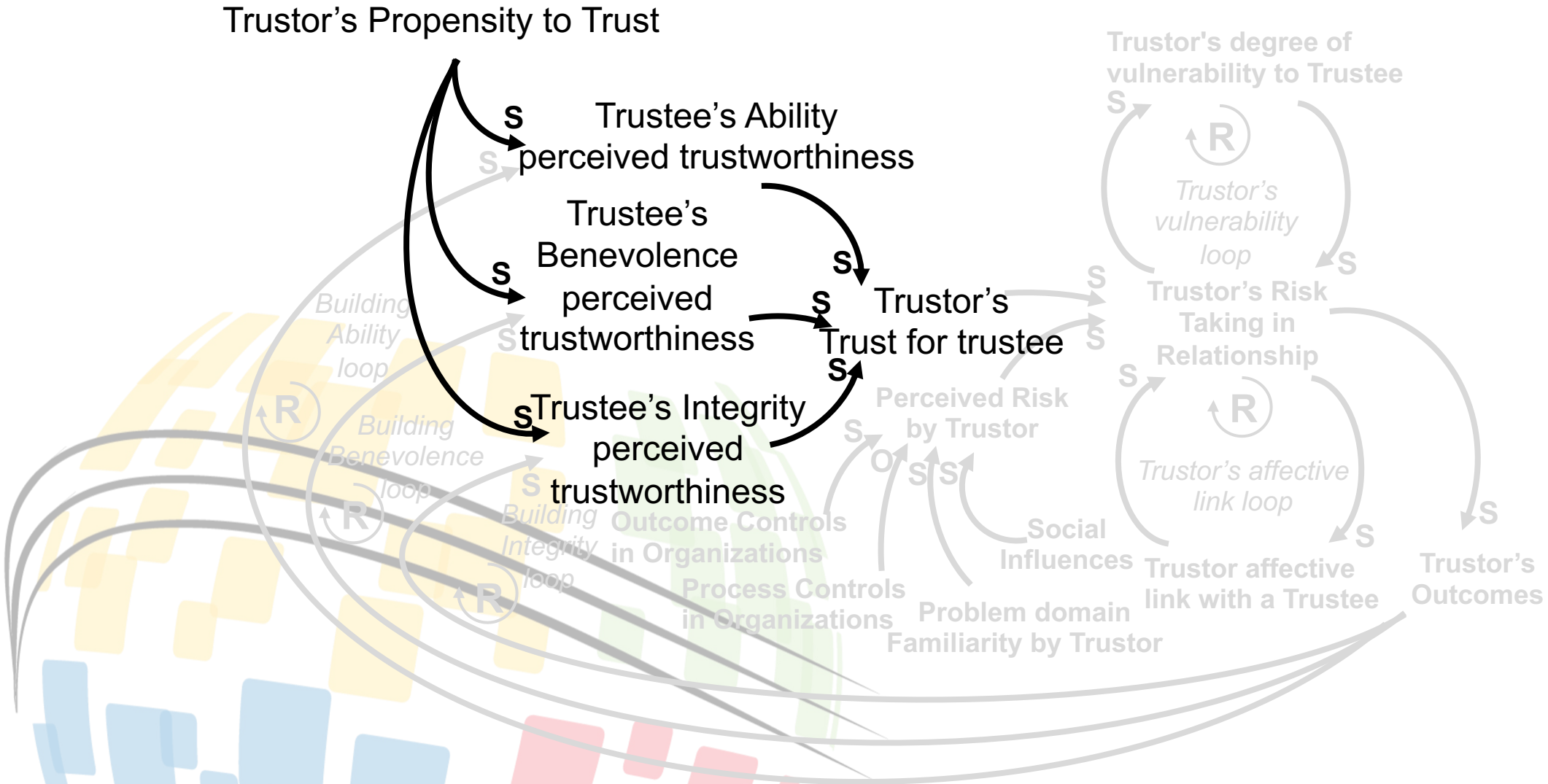


(Mayer, Davis & Schoorman, 1995, pp. 716-720)

Elements and Variables of MMT

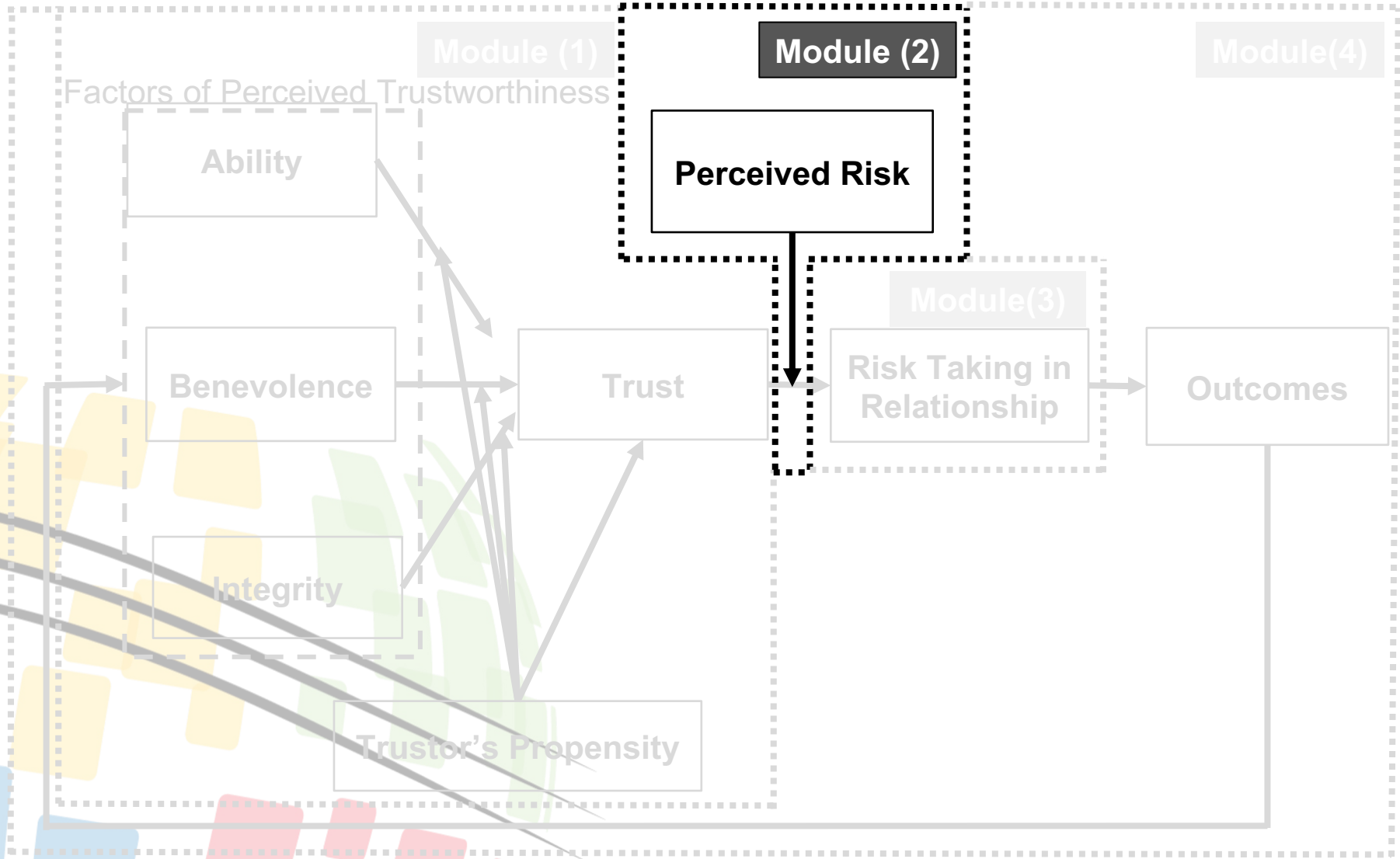
Elements	Variables
Ability	Trustee's Ability perceived trustworthiness
Benevolence	Trustee's Benevolence perceived trustworthiness
Integrity	Trustee's Integrity perceived trustworthiness
Trust	Trustor's Trust for Trustee
Trustor's Propensity	Trustor's Propensity to Trust

Module(1): Three Characteristics of a Trustee, Trustor's Propensity, and Trustor's Trust for Trustee



Module(2): Perceived Risk by Trustor

(Modules (1)-(4) were added by the author to Mayer, Davis & Schoorman, 1995, p. 715.)



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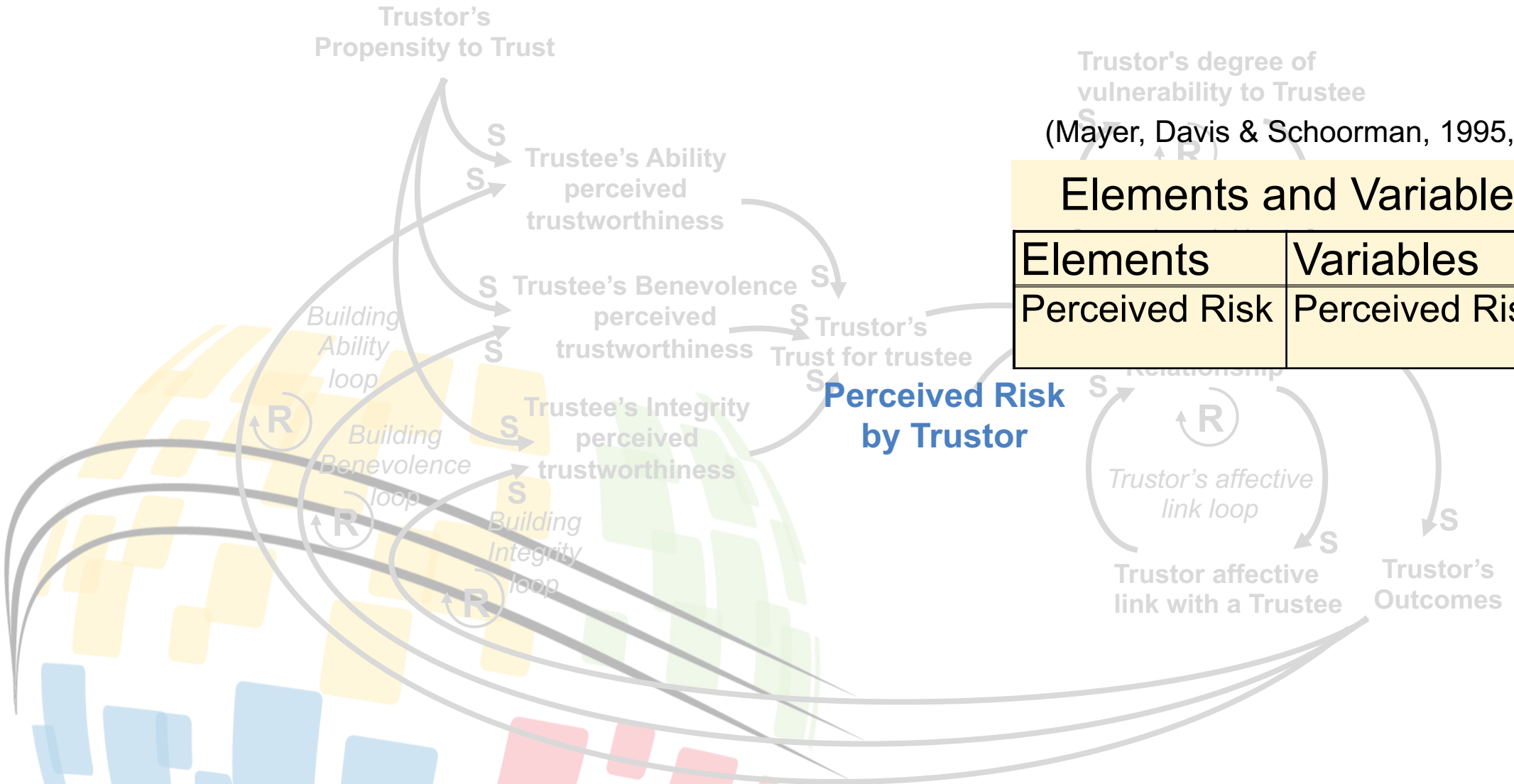


(Mayer, Davis & Schoorman, 1995, pp. 716-720)

Elements and Variables of MMT	
Elements	Variables
Perceived Risk	Perceived Risk by Trustor

Replace variables from factors written in the text but not shown in the figure

- Sitkin and Pablo (1992) identified a number of other factors that influence the perception of risk, such as familiarity of the domain of the problem, organizational control systems, and social influences.

(Mayer, Davis & Schoorman, 1995, p726)

- The greater the emphasis on process controls in organizations, the lower the level of risk perceived by decision makers.

Sitkin & Pablo (1992, p.24)

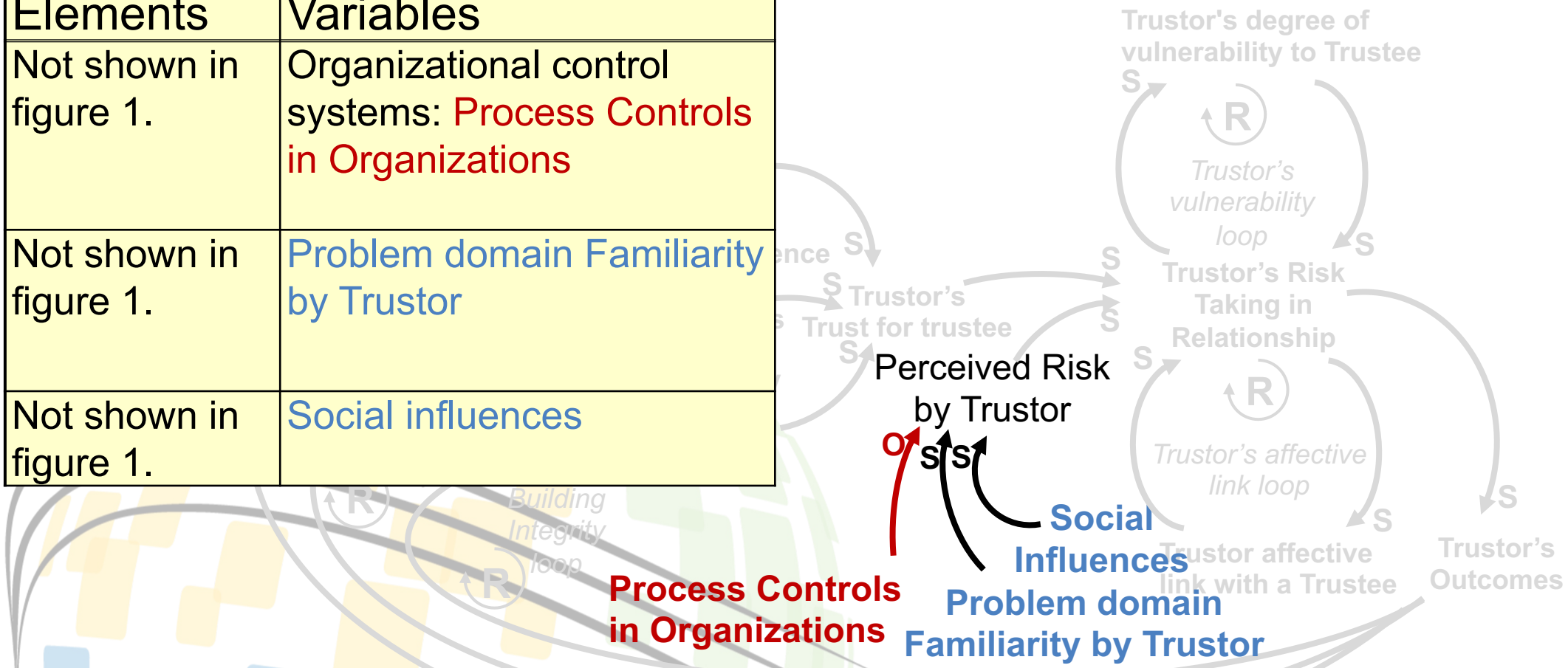
- The greater the emphasis on outcome controls in organizations, the higher the level of risk perceived by decision makers.

Sitkin & Pablo (1992, p.24)

Module(2): Example for making some links

Elements and Variables of MMT

Elements	Variables
Not shown in figure 1.	Organizational control systems: Process Controls in Organizations
Not shown in figure 1.	Problem domain Familiarity by Trustor
Not shown in figure 1.	Social influences



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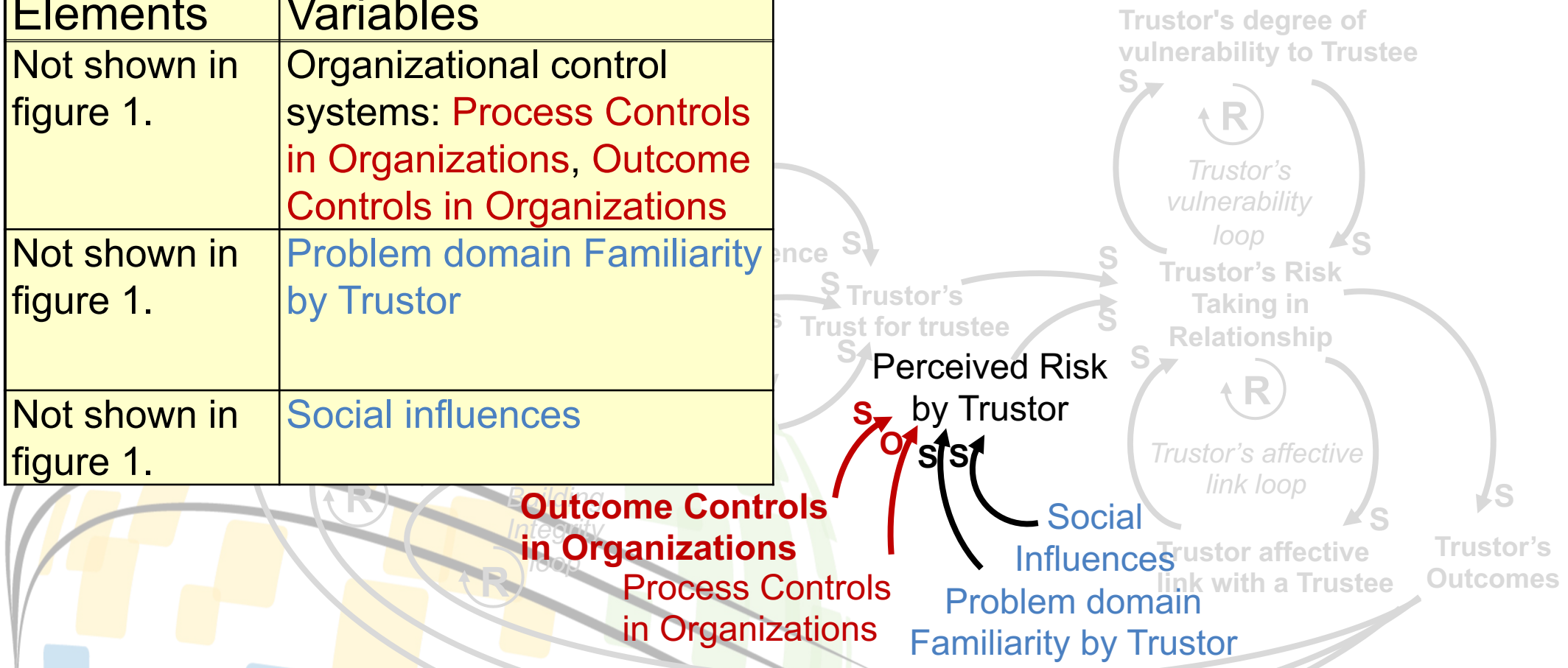
Sitkin & Pablo (1992, p.24)

Module(2): Example for making some links

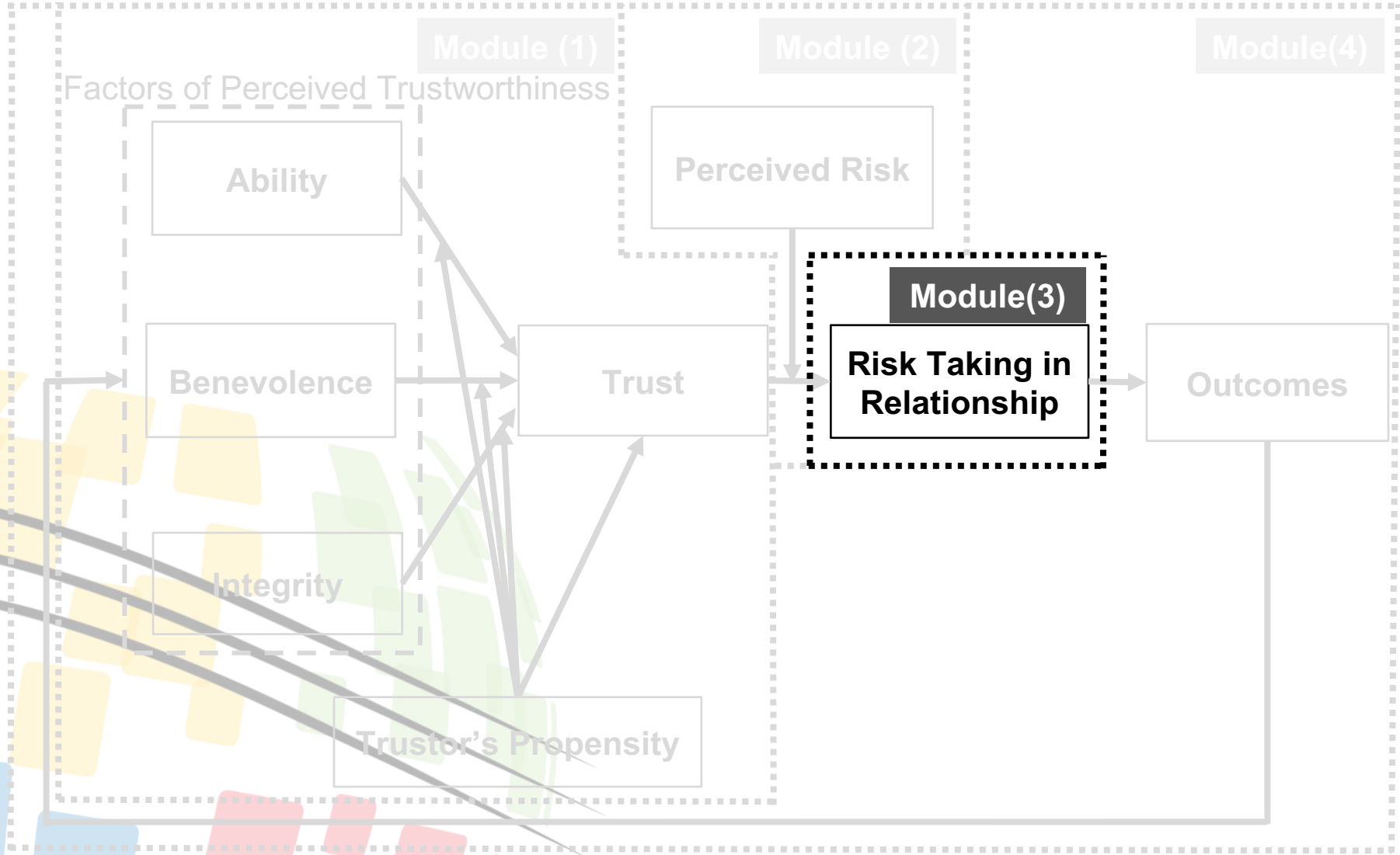
Elements and Variables of MMT

Elements	Variables
Not shown in figure 1.	Organizational control systems: Process Controls in Organizations, Outcome Controls in Organizations
Not shown in figure 1.	Problem domain Familiarity by Trustor
Not shown in figure 1.	Social influences



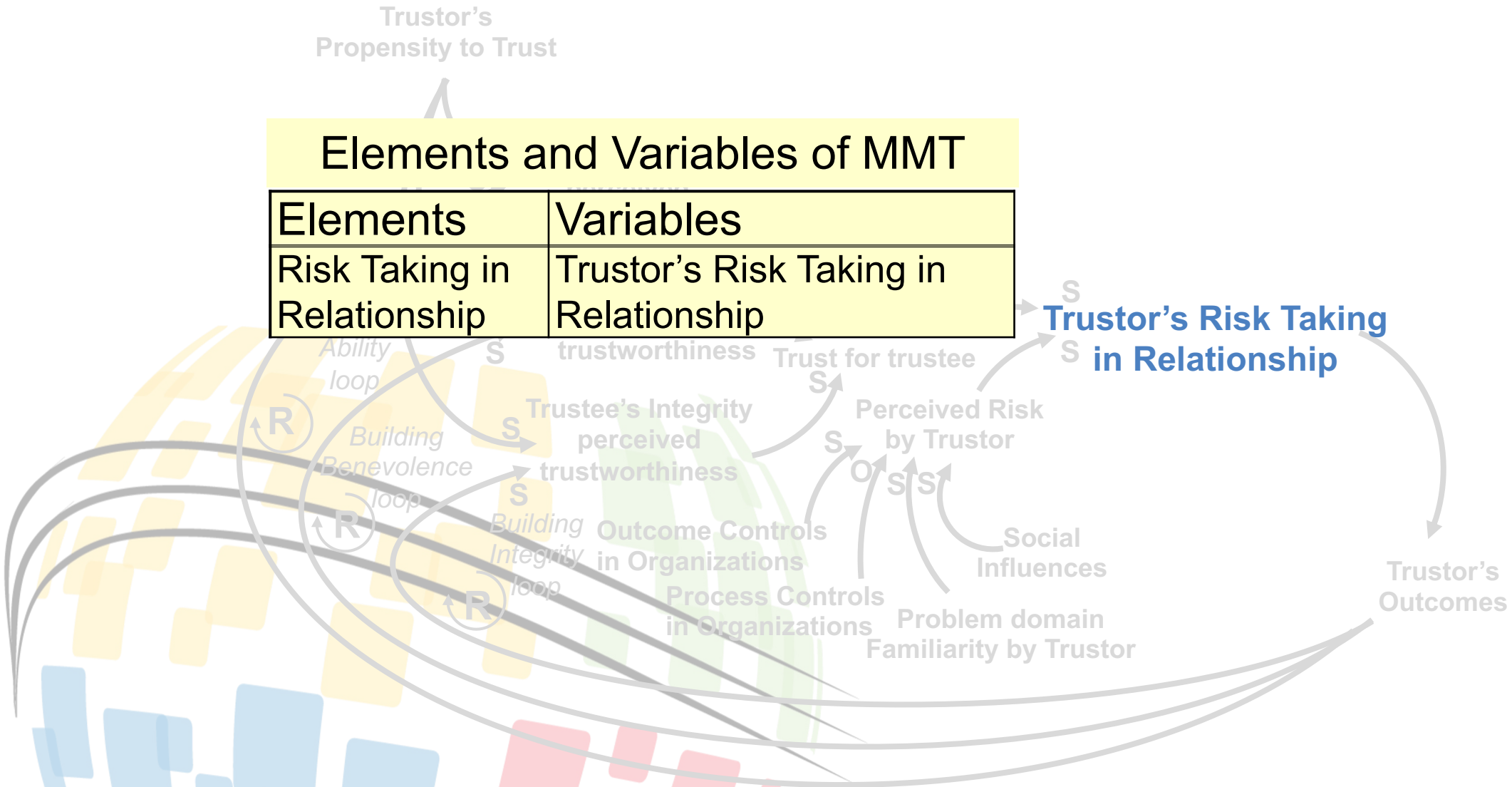
Module (3): Trustor's Risk Taking in Relationship

(Modules (1)-(4) were added by the author to Mayer, Davis & Schoorman, 1995, p. 715.)



Module (3): Trustor's Risk Taking in Relationship

Elements and Variables of MMT	
Elements	**Variables**
Risk Taking in Relationship	Trustor's Risk Taking in Relationship



Replace variables from factors written in the text but not shown in the figure

RTR: Risk Taking in Relationship

- RTR suggests that trust will increase the likelihood that the trustor will allow personal vulnerability.

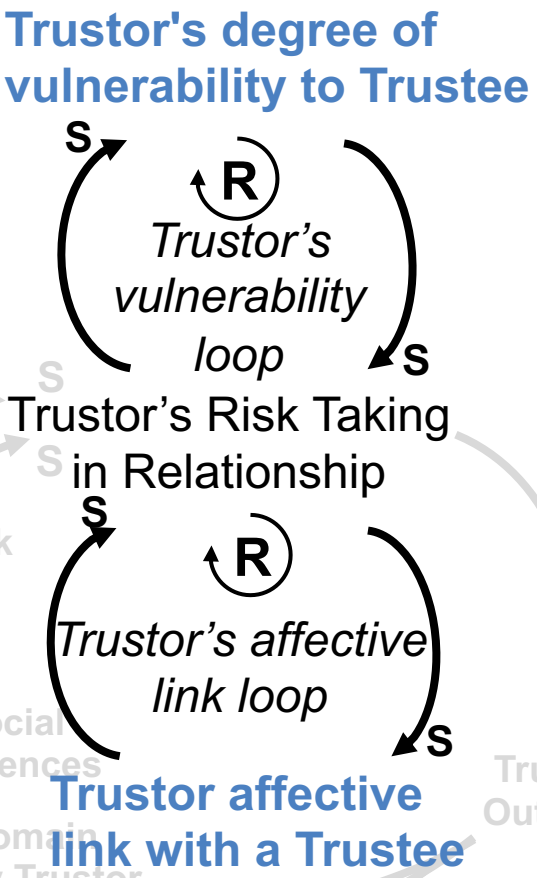
(Mayer, Davis & Schoorman, 1995, p725)

- RTR suggests that trust will increase the likelihood that a trustor will form some affective link with a trustee.

(Mayer, Davis & Schoorman, 1995, p725)

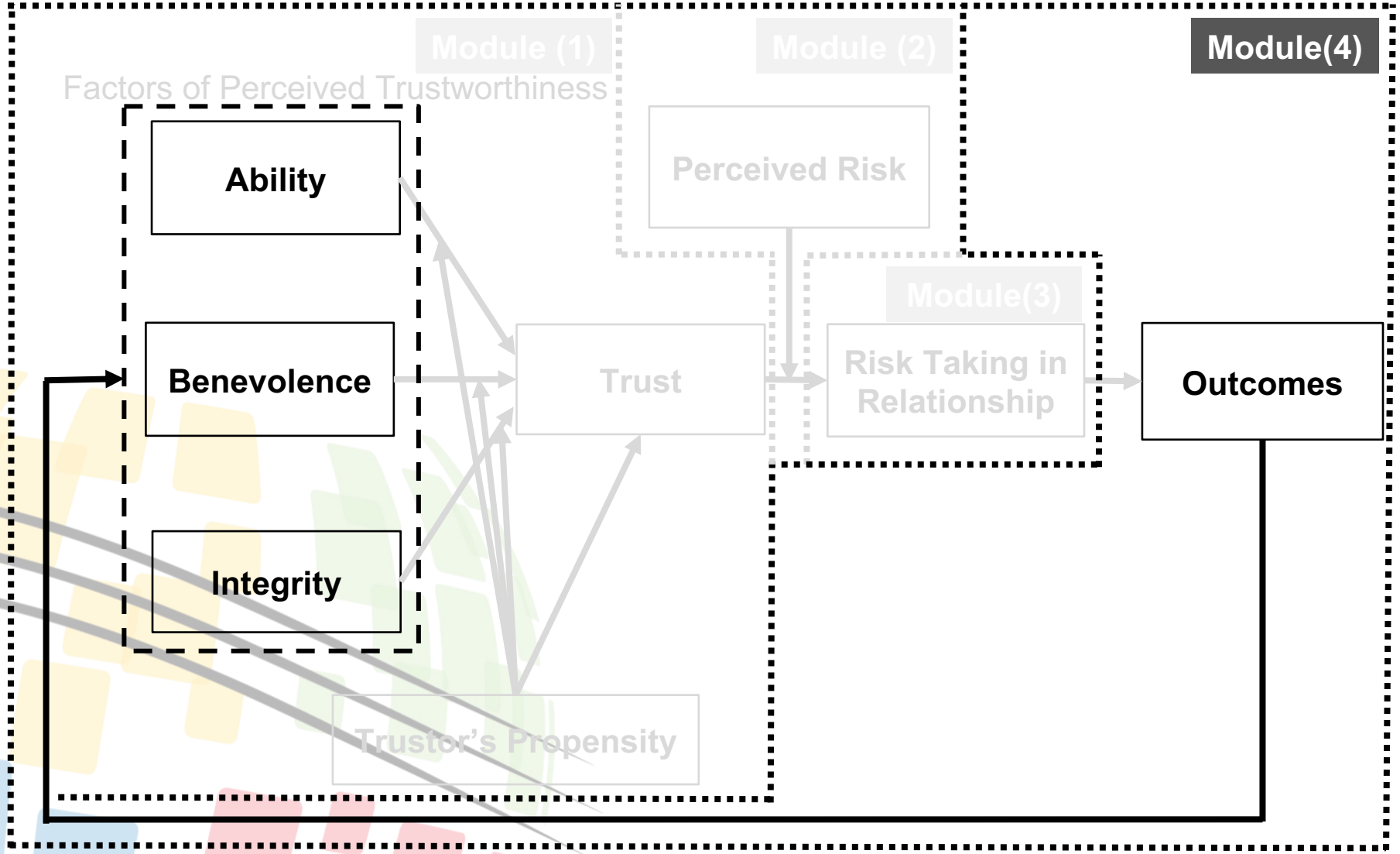
Module (3): Example for making some links

Elements and Variables of MMT	
Elements	**Variables**
Not shown in figure 1.	Trustor's degree of vulnerability to Trustee
Not shown in figure 1.	Trustor affective link with a Trustee

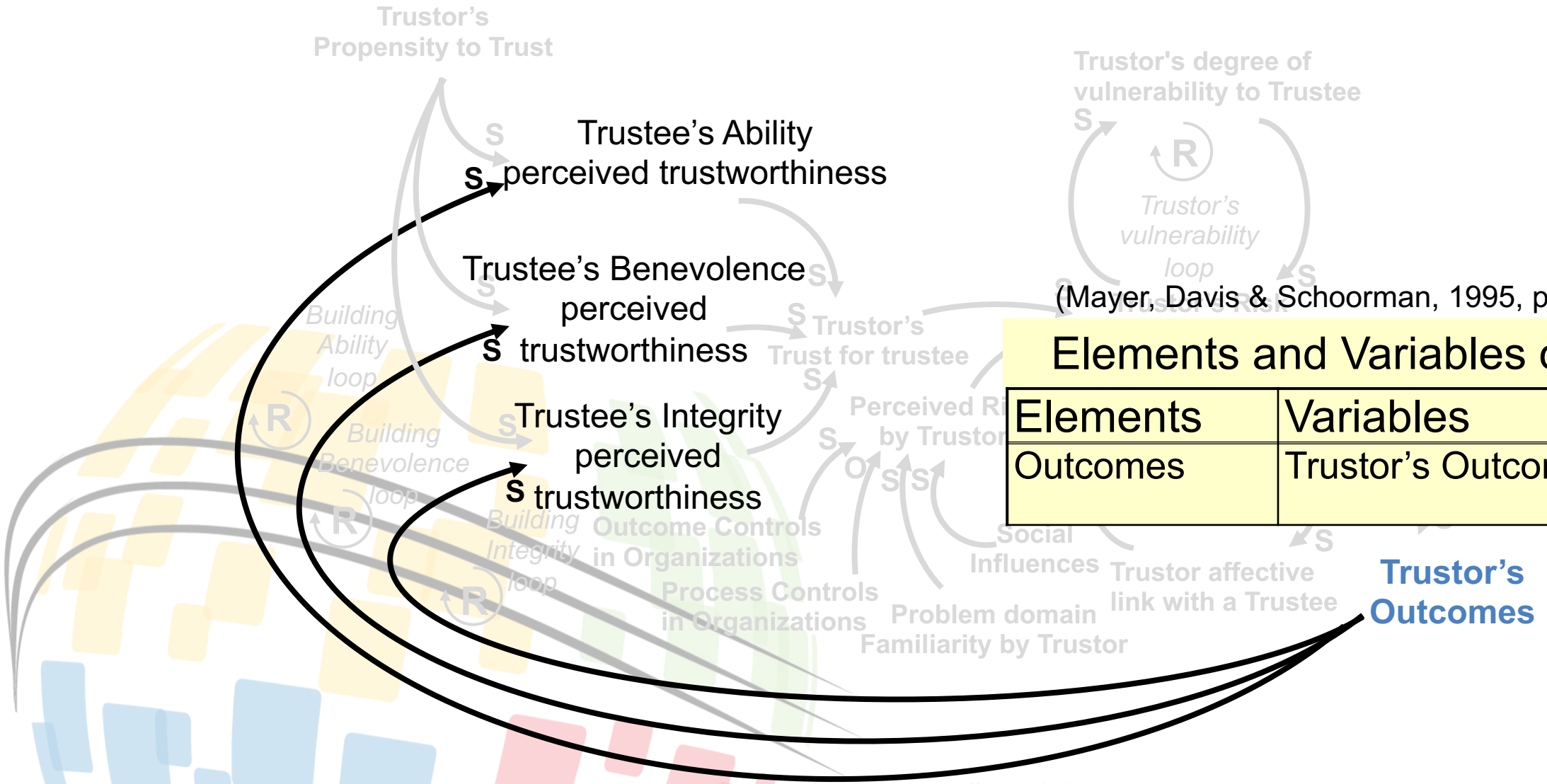


Module (4): Trustor's Outcomes

(Modules (1)-(4) were added by the author to Mayer, Davis & Schoorman, 1995, p. 715.)



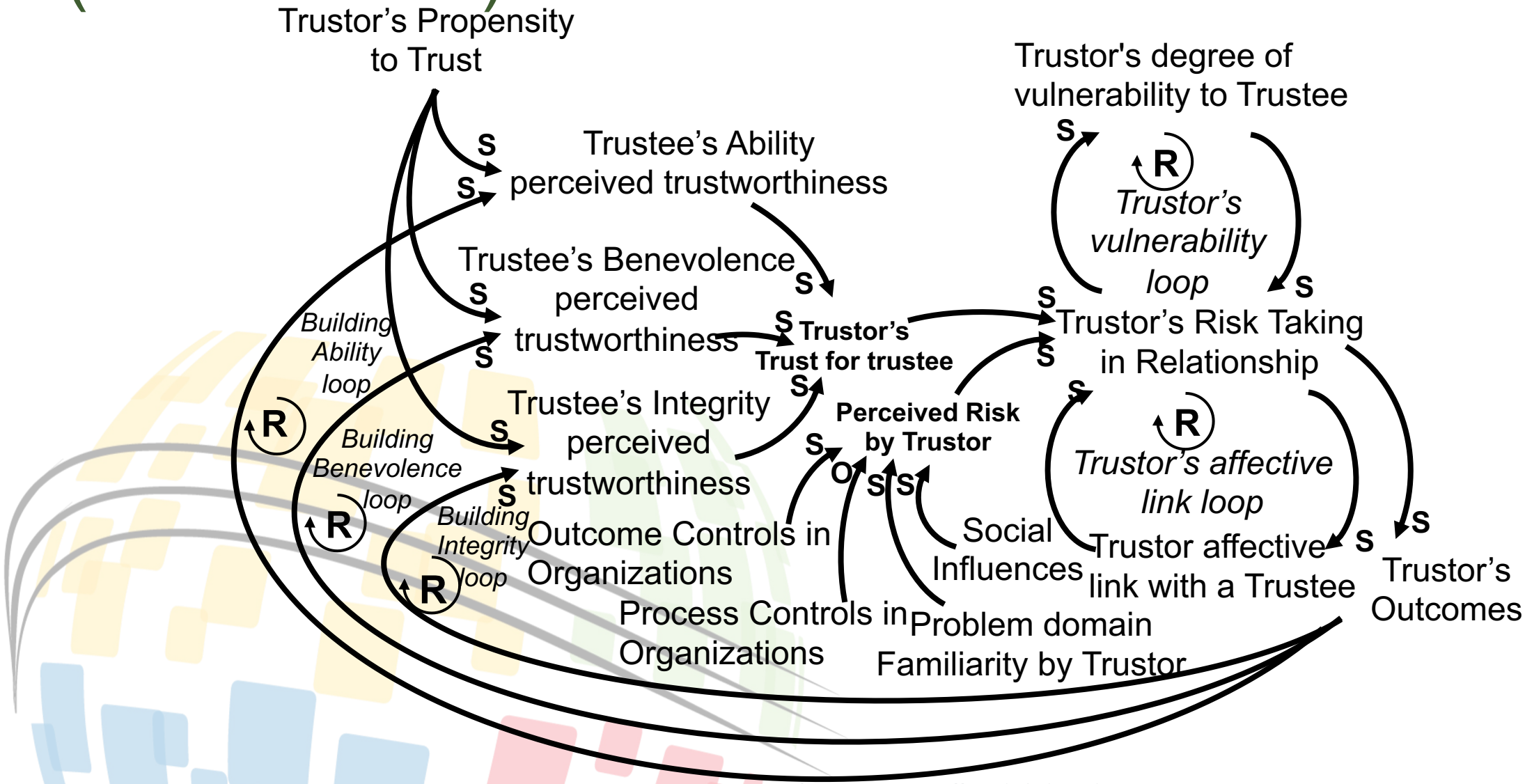
Module (4): Trustor's Outcome



(Mayer, Davis & Schoorman, 1995, p. 728)

Elements and Variables of MMT	
Elements	Variables
Outcomes	Trustor's Outcomes

Module (1) to (4): Dynamic Model for Trust (MMT based)



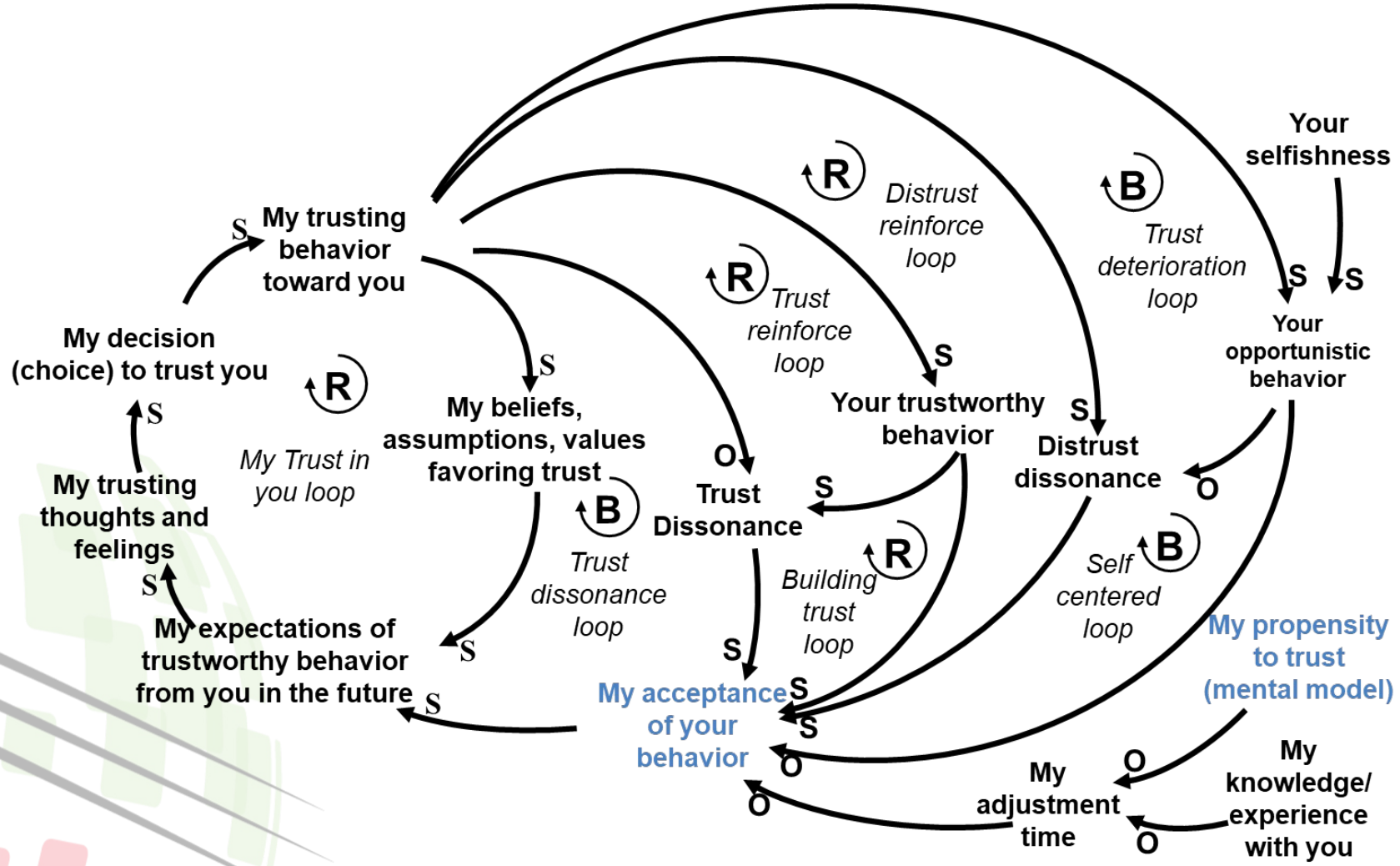
To compensate for the challenges in MMT and KMT and connect using three common variables

- Integrating the dynamic model for trust obtained from MMT as a dynamic model for trust and that obtained from KMT as a dynamic model for distrust, three common variables to both were utilized.

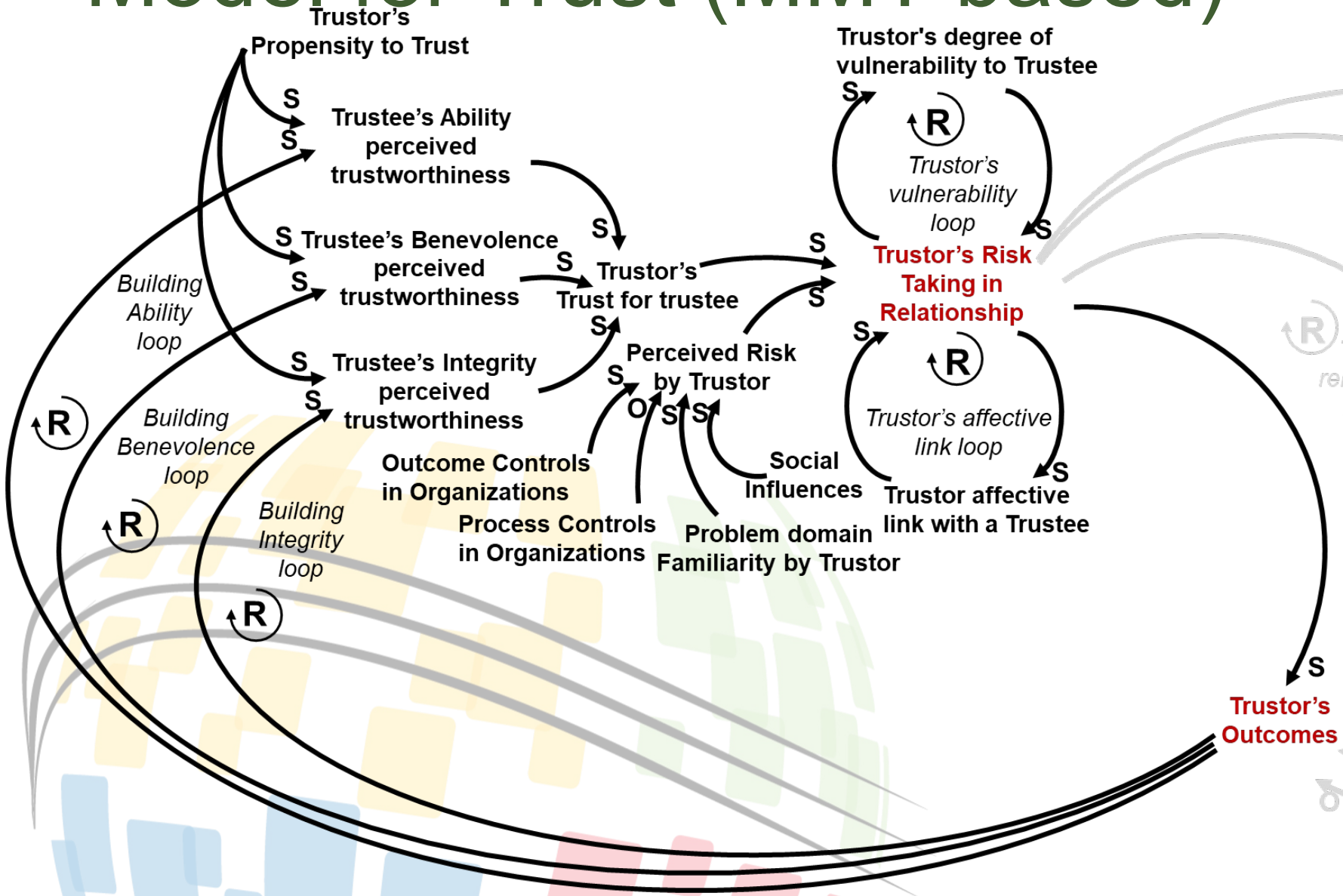
Variables of a Model for Trust and Distrust

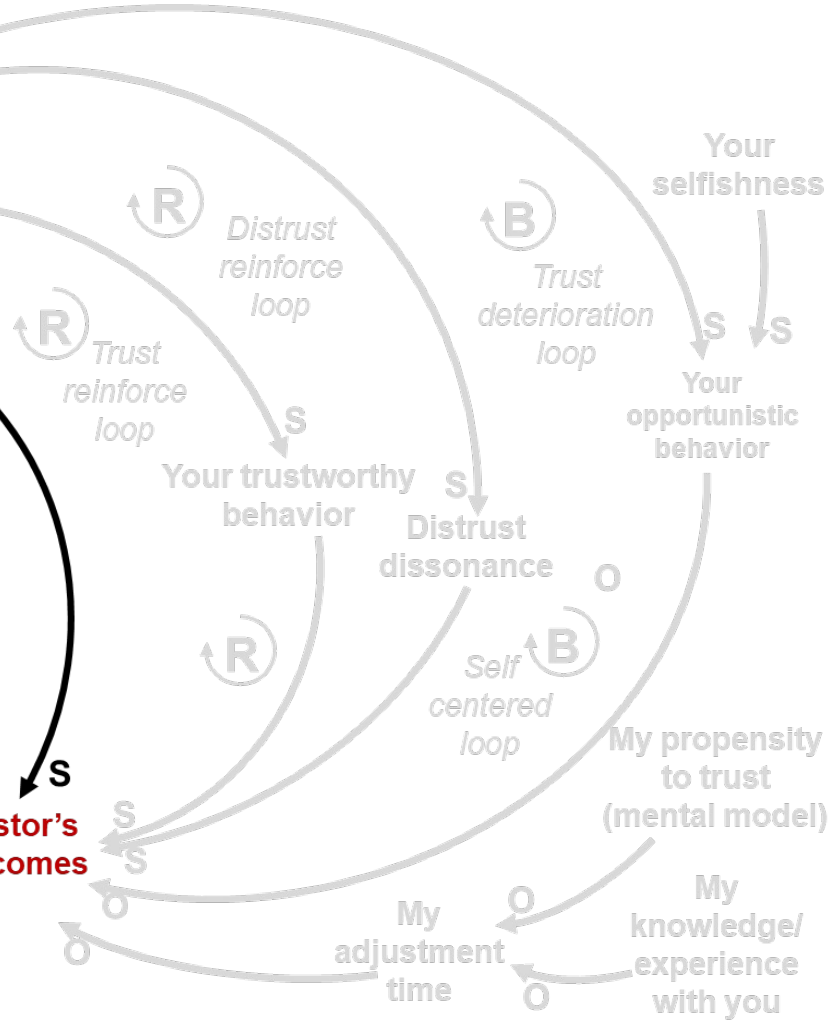
Variables of a Model for Trust and Distrust	Variables of a Dynamic Model for Trust (MMT based)	Variables of KMT for Distrust	Description
My propensity to trust (mental model)	Trustor's Propensity to Trust	My propensity to trust (mental model)	Trustor's Propensity to Trust should be viewed as equivalent to KMT's "My propensity to trust (mental model)" and should be removed.
My acceptance of your behavior	Trustor's Outcomes	My acceptance of your behavior	Trustor's outcome is equivalent to KMT's "My acceptance of your behavior", as it represents what the trustor feels, whether favorable or unfavorable, that will lead to the next step.
Trustor's Risk Taking in Relationship	Trustor's Risk Taking in Relationship	My trusting behavior toward you	"Trustor's Risk Taking in Relationship" is equivalent to "My trusting behavior toward you", as it represents the "Trustor's Risk Taking Relationship.

Kurstedt & Tech's Model of Trust (KMT)

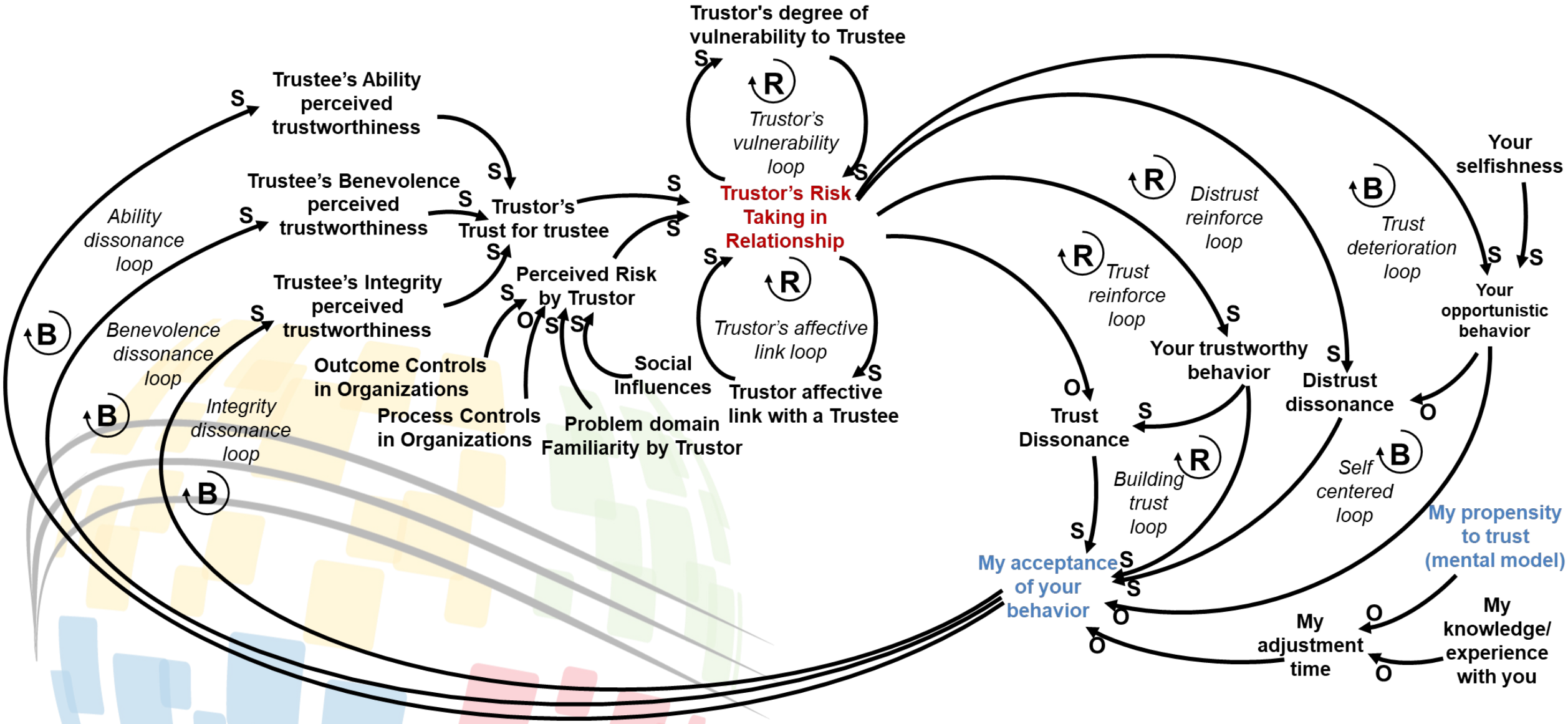


Model for Trust (MMT based)

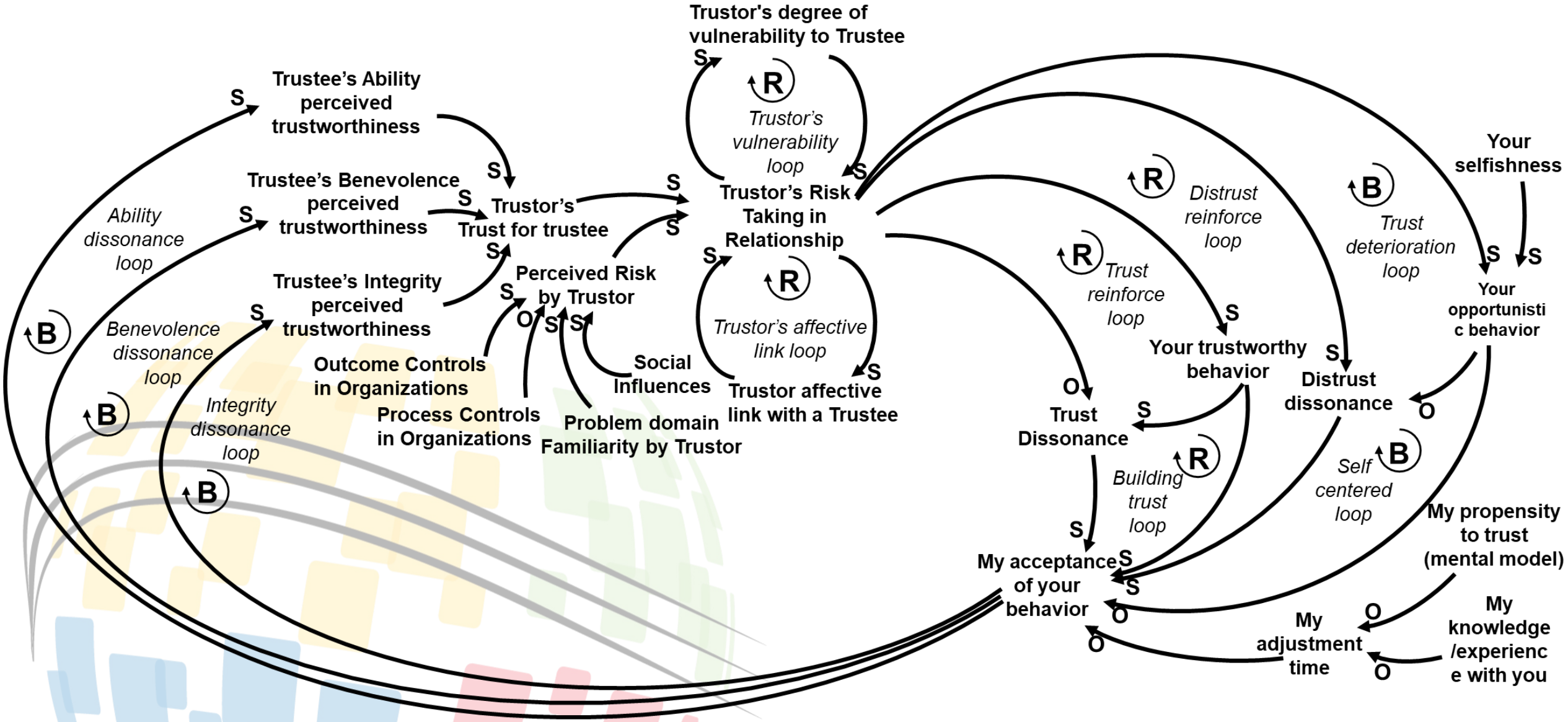




Model for Trust and Distrust



Model for Trust and Distrust



Conclusions

- This study aimed to advance trust research from person-to-person, people-to-automation, and AI.
- The contribution of this paper is to compensate for the challenges in MMT and KMT and connect them using common three variables in a causal loop diagram.
- A limitation of this study is that it integrated the causal loops of trust and distrust but did not review the respective variables.
- The study did not allow for expert review or statistical analysis of the variables and their relationships.

Conclusions

- Future research will contribute to trust research by showing not only the elements but also the dynamic relationships in matters pertaining to the differences among trust, reliance, and dependability, as discussed in the context of human and automation and AI.

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Biography

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- Project assistant professor
- The Graduate School of System Design and Management, Keio University.
- Master’s degree from Keio University.
- I worked for NEC Corporation as design engineer and business manager of broadcast and mobile base station transmitters for more than 30 years.
- Main research interests are trust and conflict from human to human and technology.

Biography

Seiko Shirasaka

- Professor at the Graduate School of System Design and Management, Keio University.
- Master’s degree in Astronautics from University of Tokyo and a doctoral degree in Systems Engineering from Keio University.
- He worked for Mitsubishi Electric Corporation as space systems engineer for 15 years.
- Main research topics are System development methodology especially systems architecture.

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